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THE AXE.

The subject of retrenchment is very much in the air and, in view of enquiries that will probably be set on foot from outside, I suggest that the Forest Department should initiate self examination to see if it is practising economy in the truest sense of the word. Since we as a Department, produce so much revenue there can scarcely be any question of *retrenchment* as generally understood, but I believe there are several directions in which economy is possible. The word is here used in its truest sense—namely, making the fullest use of everything, and not as it is sometimes interpreted, *i.e.*, parsimony. In this Province at any rate parsimony will only kill the goose that lays the golden egg—perhaps not next year or the year after, but certainly in ten years or less.

2. "Economy" slips to close envelopes, of such poor quality that in any case one journey through the post destroys them, will not save the country from financial worries:—so far as can be seen at present they merely increase the total amount of paper

used; nor will ungummed stamps relieve the exchequer to any great extent. After all what we save on postage the Post Office loses so that it comes to the old story of "losing on the roundabouts what is made on the cocoanuts."

3. If saving of paper is necessary let us follow the procedure in this province when a trader wants to work out some timber under license. First he applies for a prepaid license and if his application is granted he is provided with chalans, in duplicate, to enable him to pay the royalty into the Treasury. Then he gets a license which is filled up in three parts, the size of the full sheet being 17″ × 13½″. The form is bilingual and approximately fifty blanks in it have to be filled up. Armed with this document the trader can cut his timber. Stop! I am getting on too fast, for before he can trade at all, he must register a property mark. When he applies for one his design has to be approved and duplicate chalans issued for the fees. He then gets a Certificate of Registration (13½″ × 8½″ including counterfoil) but this does not allow him to *use* a hammer as he still must take out a "License to possess, carry and use a Hammer or other implements for impressing a Registered Mark on Timber" (Bilingual, 34 blanks to fill in, duplicate, total size 17″ × 13½″). This document is supplemented by Permits to "Carry, and Use a Hammer or other implement, etc., etc." (Bilingual, about 40 blanks to be filled, size 13½″ × 8½″) which must be filled in by the trader to allow of any employee using his property mark. Hammer licenses are renewable so that clerical work and paper consumption go on for ever. The persevering trader however surmounts these masses of paper and brings out his timber which is duly measured up and recorded in a measurement book. The D. F. O. however has not finished as he has to fill up a Register of Timber Licenses. Five of these are maintained to record five classes of timbers. *This* form only contains 26 columns to be filled up for each license.

But to get back to the timber—a bill (17″ × 13½″ bilingual, 7 blanks and 8 columns to be filled in) is then issued and the timber is marked as having paid royalty. An ignorant

commentator would think that the trader now owns the logs and could do what he likes with them. So he can if he wants to burn them on the spot, but there is precious little else he can do without more documents. If he wishes to convert them even in the Division of origin he must take out a sawmill or sawpit license. These are neat little bilingual forms with about 40 blanks to be filled in, $17\frac{1}{2}'' \times 13\frac{1}{2}''$ and $13\frac{1}{2}'' \times 8\frac{1}{2}''$ in size, respectively. The D. F. O. naturally enters these particulars again, in a register this time of course, but the sawmill man has to execute an Indemnity Bond, so on the whole they are all square on the deal.

4. If the trader however wants to move the timber to a market outside the Division of origin he must produce his title to the timber (*i.e.*, Bill) and take out a Removal Pass *for each consignment and further the pass must accompany the logs*. Of course the last condition is unworkable in the case of truck loads of logs; but it looks well on paper. The pass itself is the father and mother of all forms, filled up in quadruplicate, bilingual, 48 blanks to be filled in (including 4 pen and ink pictures of the design of the marks impressed on the timber—very frequently several marks in practice). The original is handed to the would-be-transporter of timber—a duplicate sent to the Station-Master concerned (in case of railway consignments), another to the unfortunate Forest Officer at the other end, and the counterfoil is kept in the office. The copies for Station-Master and Forest Officer are usually posted—two envelopes *with* economy slips naturally, and sometimes two half-anna ungummed stamps where one anna stamp (ungummed variety) would do equally well.

5. With good luck the logs land up in some large centre and are taken to a sawmill. Every log is there entered by a Forest Subordinate in the Sawmill Register (a really nice new cast-iron copper-bottomed, bilingual form has just been invented for this, I am told, but not yet being in circulation, I cannot describe it) and crossed off when duly converted. The sawmill man may then want to sell his timber at some distant place. He can do *that* of course, but he may not remove it thence (if

outside Division in which the sawmill is) until he has taken out another Removal Pass as described above—copies of course being distributed to all concerned. I have omitted to mention that all Removal Passes must be returned to office of origin in due course. In fact by the time a scantling goes into consumption the paper used in connection with it approximates to its own volume.

6. Why should I be able to buy a bottle of whiskey at the Club and take it home with me without a removal pass? The duty on it is much higher in proportion than on timber but the Customs people don't worry because they watch the *source* of that whiskey—tax it there and wash their hands of it.

7. The Forest Department employs many clerks and subordinates on this *paper control* of produce in transit and trained officers have to spend too large a proportion of their time on supervising both. Let us put all our watch dogs at the source or at least examine the possibility of doing so. As a matter of fact we have dogs on the spot and the revenue staff on transit-watching duty is a confession of failure at the source.

(N.B.—I have left out many accounts of the traders' views on the above subjects.)

ESTABLISHMENT.

8. In the year 1920-21, 2,12 lakhs of rupees were spent in India by the Forest Department on Conservancy and Works and 1,51 lakhs on establishment or well over 40 per cent. of the total. Of course this does not mean that it costs us Rs. 40 to spend 100 but out of every rupee a good deal must go as the cost of spending it. The proportion of B. Expenditure to the total varies enormously between the Provinces. Making allowance for higher salaries, different rates, etc., *are the relative proportions more or less equal* in provinces where other conditions are the same? *If not, why not?* Many officers regard more staff as the panacea for all ills, and individual ideas on the point are quite irreconcilable, at any rate in this province if reports be true.

9. Are we making the most economical use of every officer, clerk and subordinate? Is it economical to employ even part of the time of a trained officer writing out drafts to be typed when he could dictate them to a Stenographer in a fifth of the time and spend the time saved on productive work. Of course I should be told, that he would not do any more work, but would merely have more leisure. I do not believe it, but in the case of some officers it would be a jolly good thing if they had more leisure; less crocking up for 4 or 5 days a month—extra leave on M. C., etc. The stenographer would cost more than a typist but the extra money would be productive in 99 cases out of 100. The question arises whether a D. F. O. should write a letter at all and whether it would not be better to employ a P. A. or headquarters Assistant who would deal with all correspondence and accounts, putting up important cases for orders as a Secretary does. Instead of splitting divisions we could probably double up some and keep others as they are thus carrying on just as efficiently without so many I. F. S. men.

10. Even with things as they are, do we carry on as efficiently as we ought? Is the best man for any job always taken regardless of the great god Seniority? Study your Provincial list from top to bottom and think it over.

11. Lest some unkind critic may write me down as a disgruntled grouser, let me say I am in a very congenial job, thank you, and would not change with any one. I have not been passed over for promotion and am not likely to be for years and years as I am merely quite

JUNIOR.

THE TRANSMISSION OF SANDAL SPIKE.

Since the publication of my bulletin on Sandal Spike in 1917* the staff of the Agricultural Department has been continuously engaged on the investigation of this disease. During this period a large amount of scientific information has been collected with which I do not propose to deal here. I shall confine myself to a description of some interesting results but recently obtained with regard to the natural spread of this disease.

Our work which has been described previously has already shown conclusively that Sandal Spike can be transmitted by means of grafting. We have produced the disease by this method in dozens of cases and have yet to come across a case where the diseased scion really formed connection and grew without transmitting the disease to the stock and finally leading to the death of the formerly healthy tree. On the other hand in every case where the scion did not form connection and died no spike has appeared on the stock no matter how severely it has been cut back.

Up till recently, this has been the only experimental method we have had transmitting the disease, although the most varied methods have been tried. Now it is perfectly obvious that this is not the natural method of transmitting the disease. The disease in nature must be transmitted either through the roots or through the portion of the tree above ground. The fact that sandal trees readily form haustorial connections with the roots of other sandal trees makes the probability of root transmission very great but as far as I am aware no clear evidence has yet been adduced to prove that the disease is actually transmitted in this manner. To settle this question the following experiment has been carried out.

During 1916 a number of seedling sandal trees were transplanted in twos or threes in common pits in the laboratory compound, the two or three trees in a pit being separated by only a

* Coleman, Spike Disease of Sandal, Department of Agriculture, Mysore State, Mycological Series—Bulletin No. 3, 1917.

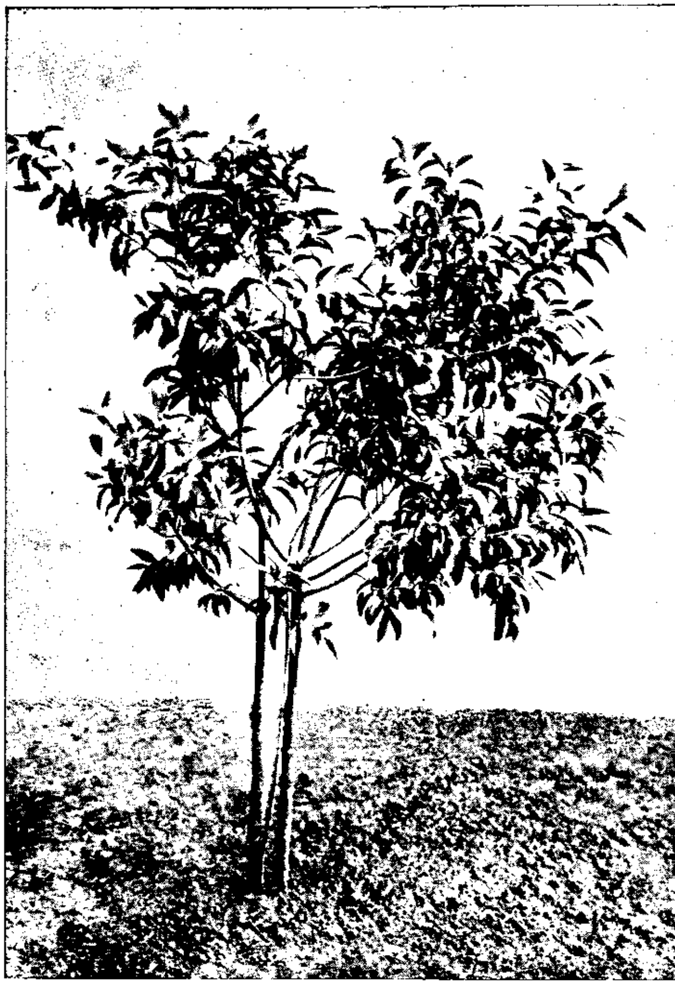


Fig. 1—Three Sandal trees transplanted into a single pit to allow for experiments on transmission of spike disease.

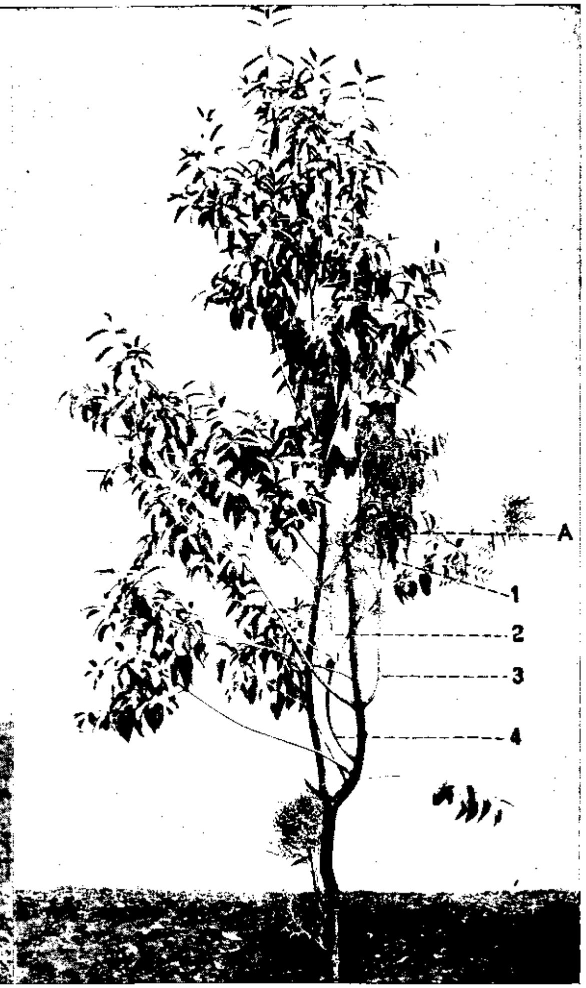
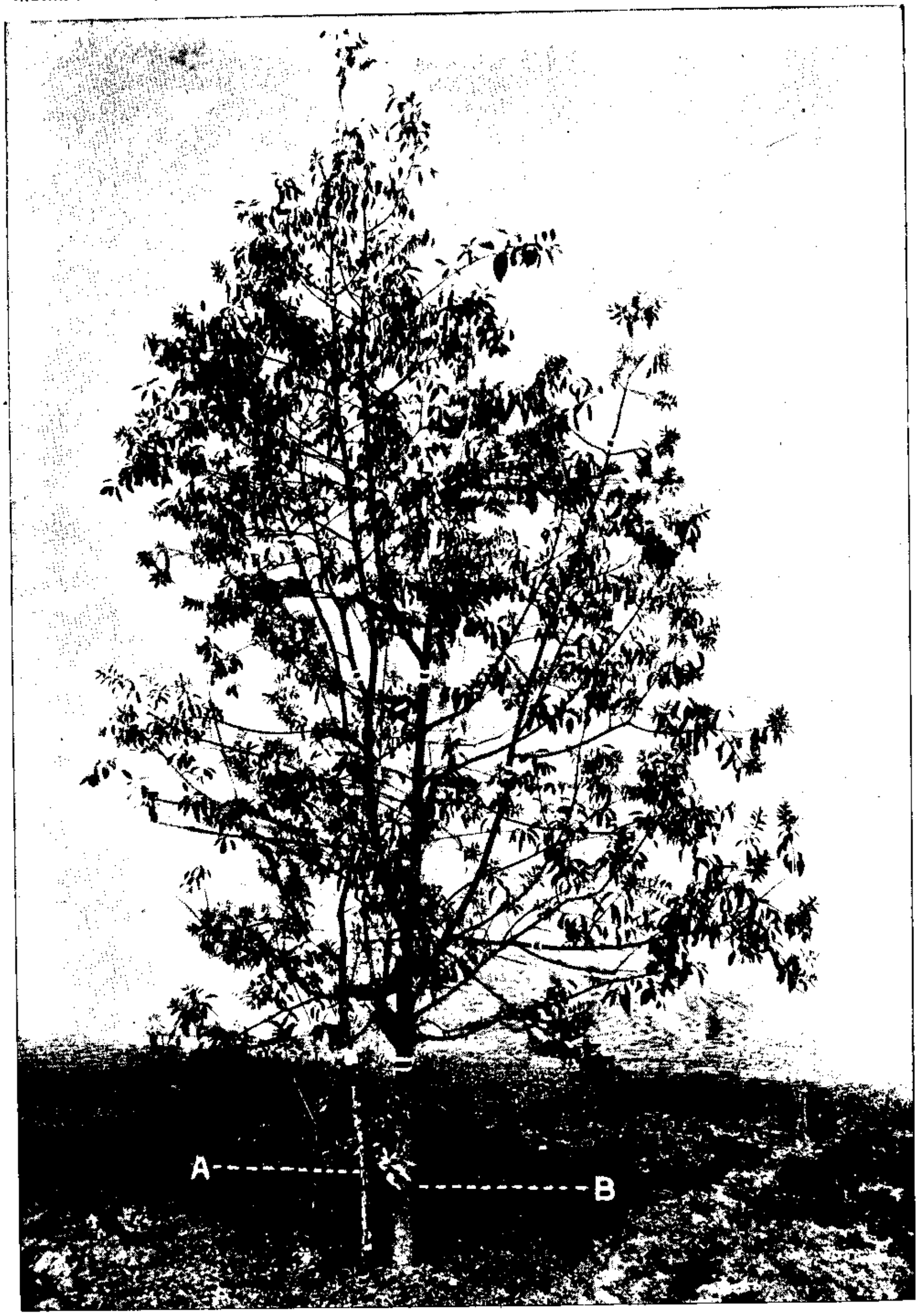


Fig. 2—Sandal tree on which spike disease has been produced by grafting. "A" shows point of attachment of graft. 1, 2, 3 & 4 mark branches showing spike.



TRANSMISSION OF SPIKE.

The spike disease first given to tree "A" by grafting has been transmitted to tree "B" *via* the haustoria.

few inches. These trees were left to grow till June 1921 chiefly to enable them to develop a good root system so as to ensure their forming haustorial connection. Plate I, Fig. 1, shows three of these trees growing together.

In June 1921 a single individual in a number of these groups was grafted with bits of branches from a diseased tree. I shall trace the history of one of these young trees (marked A on Plate II). This tree was grafted on the 11th June 1921. The scion grew, producing, as is invariably the case in such experiments, typically spiked leaves of the stage shown by the tree from which the scion was taken. The disease appeared on the stock (in the form of spiked leaves) in September 1921 or about two months after the grafting took place.

On the 1st of July 1922 or over a year from the beginning of the experiment the disease was first observed on the adjacent untreated tree (marked B in Plate II). The remarkable thing about it was that the disease broke out simultaneously in all parts of the tree, almost every end twig breaking out into spike at practically the same time. This phenomenon is quite different from what happens when the disease is produced by grafting. In that case the disease appears gradually to spread from the point of grafting from branch to branch. This is shown very clearly in Plate I, Fig. 2, in which A shows the point of attachment of the scion since broken off by accident and 1, 2, 3, 4, the order in which branches have developed external symptoms of the disease. It will be seen that the main part of this young tree is outwardly still quite unaffected.

The disease on Tree B was allowed to develop for two months and the roots of the two trees were then laid bare as carefully as possible by washing with a jet of water. Any one who has ever carried out this operation knows how extremely difficult it is to preserve haustorial connections the rootlet bearing the haustorium usually breaking away at the slightest disturbance just at the apex of the haustorium. However three haustorial connections were definitely established between the two trees. In two cases the haustoria belonged to the ungrafted tree (B)

and were attached to the roots of the tree (A) to which the disease had been communicated by grafting. In the other case the haustorium belonged to tree A and was attached to a root of tree B. Plate III, shows clearly the first two of the three haustorial connections described above. I may note in passing that these haustoria were not dead and were apparently still functioning. One has been removed with a piece of the host root for sectioning and microscopic study.

A large number of haustoria were unearthed. Some of these formed connections between two roots of the same tree while others were attached to the roots of a cork tree, *Millingtonia hortensis*, L. growing near by. In all probability a number of the haustoria the connection of which could not actually be established really formed connections between the two trees.

We have two other cases of an apparently similar nature at present in the compound. In both these cases the disease has spread from a grafted tree to an ungrafted tree in the immediate neighbourhood. The roots of these trees have not yet been exposed so haustorial connection in these cases remains to be proved.

The fact that two of the above described haustorial connections were of the ungrafted tree on the grafted one is interesting. It is, I think, quite easy to see how the infective virus or ultra-microscopic organism could be taken up by these haustoria and carried into the tree which had previously been healthy along with the sap stream. An infection in the opposite direction where the grafted tree has become connected through a haustorium with a root of the ungrafted tree would perhaps be more difficult to understand though I personally believe that any organic connection between the two trees would lead to infection.

The results of this experiment show, I think, as conclusively as it will ever be possible to do that spike disease can be and is transmitted by way of the haustoria. It seems to me, at the same time, pretty conclusively to dispose of the theory of an external cause for spike disease. The disease has been transmitted from a definite source to a tree which for five years had

Root systems of trees A & B exposed to show haustorial connections between the two at X.

Note that tree "B", the originally healthy tree, is the parasite in this case.

grown in a perfectly healthy manner and on which not the slightest cutting back or other mutilation has been practiced. This tree has grown in an area carrying at least one hundred sandal trees where prior to the appearance of the disease now noted not a single case of spike has occurred except as a direct result of grafting experiments.

It appears to me unlikely if not impossible that the natural transmission of spike disease of sandal takes place only through the haustoria. I may point out here that since the publication of my bulletin on this subject a very large amount of information has appeared with regard to similar diseases in other parts of the world. New diseases of the same general type have been discovered in very large numbers and in the case of many of them insects have been definitely proved as agents responsible for the transmission of the disease. As far as I am aware no evidence has as yet been obtained indicating that insects are responsible for the transmission of spike disease but comparatively little work has been done on the subject. Now that the communication of the disease *viâ* the haustoria has been established we propose taking up this phase of the subject more vigorously.

LESLIE C. COLEMAN,
Director of Agriculture
in Mysore.

NOTES ON AN ENTOMOLOGICAL TOUR IN THE UNITED STATES OF AMERICA AND CANADA.

Forest Entomology in U.S.A.—The writer has lately returned from U.S.A. after having been granted permission by the Indian Government to make use of a Carnegie Research Studentship with the special purpose of studying forest entomology with the U.S. Bureau of Entomology. The writer wishes to express his thanks to Dr. L. O. Howard, the Chief of the Bureau, to Dr. A. B. Hopkins and to all the officials of the Bureau he was able to meet for their uniform kindness and assistance. Dr. T. E. Snyder and Mr. W. Middleton were of the greatest assistance in laboratory work and in arranging field trips in the Washington district.

The first period of the nine months' visit was spent at Washington D.C. in studying literature, systematic entomology and also in studying Coleopterous larvæ with Dr. A. G. Böving, who generously allowed full use of much unpublished work. The remaining period from March 1921 to July 1922 was spent in a tour through the Southern and Western States returning to Washington D.C. through Canada. Numerous stops were made on this route to visit entomological field stations and the following notes were made on points which seemed of special interest.

Forestry in U.S.A.—Before considering the organisation of the Division of forest insects, it may be of interest briefly to state the conditions existing in the forests of the United States.

Ownership is divided between the Federal Government, the States and private owners, the last being by far the most important of the three as three-quarters of the forest area belongs to to them and depends solely upon them for management. While the Federal and State forests are managed scientifically, the private owners have disregarded the question of regeneration of felled areas completely, their object being to extract only the finest trees at the least possible expense ; when it is remembered that the private owners appropriated the best of the forests before the establishment of the National Forests the seriousness of the situation can be realised.

Results of past mis-management are felt most in the eastern and southern states where although princely forests existed, large enough to supply all local needs, if managed properly, considerable uneasiness is now felt owing to the closing of mills for lack of timber and the necessity for importing timber, particularly from the west and from Canada : the paper makers of the north-eastern states are dependent on Canadian supplies for their pulp.

In contrast to these conditions there is abundance of standing timber in the west, although it will be only a question of time before the more accessible timber lands are spoiled if present methods continue. The difference between the eastern and western states in their outlook on forestry is shown to some extent in the teaching of their forestry schools : in the east great

attention is paid to conservation while in the west the training is adjusted to the great demand for men with a training in extraction and utilisation.

An idea of the losses due to fire, insect damage, and bad lumbering, is best obtained from figures issued by the Forest Service, which state that there are now about eighty-one million acres of former forest land devastated by lumbering and fire alone. The official estimate for forests destroyed by fire in 1918 was ten million acres, and in 1919 eight million acres. Losses due to insect attack are difficult to estimate, but it is agreed by the authorities that damage of this kind to mature timber is greater than the fire damage.

Although at present the activities of the Division of forest insects are largely centred on direct control of existing epidemics, as for example, in the bark-beetle outbreak in the western states the future of forest entomology lies in the utilisation of the results of entomological research for preventive purposes in the formation of working plans. Until the Federal Government has the power to safeguard the public interests in the conservation of all forests, whether privately or publicly owned, by insisting on scientific management and protection, there must be continued waste and deterioration.

The Forest Service is actively emphasising the importance of conservation and the Government aims at purchasing forest land, stocked or waste, until at least 50 per cent of the total forest area is held.

In addition to the forests administered by the Forest Service (under the Department of Agriculture) there are large areas under the Department of the Interior, namely, the National Parks managed chiefly for æsthetic purposes and the forests in the Indian Preservations, managed for the benefit of the Indians.

It is of interest to note that, given freedom from disease and fire, natural reproduction is usually extremely easy in the United States and in many areas which have been felled over in what seemed the worst possible way, young growth has forced its way up.

The Bureau of Entomology.—The Bureau of Entomology with headquarters at Washington is controlled by Dr. L. O. Howard who, taking charge of the Bureau in its infancy, has brought it to be the most efficient organisation of its kind in the world. The bureau contains eight divisions, each of which deals with some special class of economically important investigation: one of these divisions is known as "Forest Investigations." Each Division is in charge of a Division Chief and has a staff of trained entomologists who work either at the administrative headquarters at Washington D.C. or carry on research and advisory work at the numerous field laboratories spread throughout the country. Many of these workers occupied in biologic research also specialise systematically in some insect group but there is in addition a group of systematic entomologists who work for the most part in the U.S. National Museum at Washington, where they have at their disposal a very complete collection of insects and a library. The work of the latter consists in assisting biologic workers in the identification and description of species of insects and in maintaining and improving the collections.

The Bureau of Entomology has its own Editorial Office which prepares results of research for publication in one of the several departmental Bulletins and Circulars. Some of these are purely technical, while others are intended to supply useful information in popular form to farmers and others throughout the country.

Funds are appropriated annually by Congress, the sums being based on estimates by the Chief of the Bureau.

While the Bureau of Entomology has been in existence for many years the Division of insects is of comparatively recent formation. This may be explained by the fact that until recently the great supplies and cheapness of lumber obscured losses due to insect attacks; but of late years the serious diminution of forest areas resulting from destructive lumbering methods and the consequent rise in value of timber have emphasised the importance of controlling forest pests. This led to the organisation in 1902 by Dr. A. D. Hopkins and the bringing to a high degree of efficiency of a Division of the Bureau, to be devoted to the control of insects injuring trees.

It may be noted here that the Bureau of Entomology and the Forest Service are two of the several branches of the Department of Agriculture, and while there is no direct control of the forest insect Division by the Forest Service, active co-operation exists. To state it briefly, the work of the Division consists in devising means of controlling insects destructive to forests and forest products and in advising the Forest Service, private owners and others in the application of control measures : in most large control projects the work is supervised by a Bureau expert.

The personnel of the Division is allotted as follows :—

(*a*) Six entomologists deal with Forest insects. Each is in charge of a field station situated in some important forest area and each has a number of subordinate "entomological rangers" to assist him. The latter are men, who, although not scientifically trained, are capable of making observations and guiding control work.

(*b*) Two entomologists deal with insects attacking forest products such as logs, construction timber and seeds.

(*c*) One entomologist deals with insects attacking shade trees, such as trees on roads, in parks, or near houses.

(*d*) Two entomologists divide their time in connection with (*a*) and (*c*) above.

In addition to the Federal Bureau of Entomology each State has an entomological staff of its own, but more attention is usually paid to agricultural and fruit pests than to forest pests.

The efficiency of the control measures advocated by the Division depends to a great extent on simultaneous co-operative action over extensive areas and as ownership of forest is divided between the Federal Government, the States and large numbers of private owners, this co-operation has been difficult to obtain in the past. An interesting proof of awakening general interest is shown in the law recently framed by the State of Oregon to meet this contingency : the law will be discussed later when considering the bark-beetle outbreak in Oregon.

The most important tree-destroying insects in U.S.A. belong to the family *Scolytidæ*. Dr. A. D. Hopkins, the Chief of this Division, has specialised in their classification, biology and control: his well known monographs on this subject form the basis for all control measures on forest pests undertaken in U.S.A. Dr. Hopkins has for some time been engaged in developing the science of Phenology which promises to be of the greatest use in connection with control operations and also for example with the recognition of introduceable foreign pests.

Insect damage to green saw logs and lumber.—As great damage is done by insects to timber in the interval between felling and sawing the Division of forest insects initiated experiments with a view to finding suitable control measures. In early February the writer was able to join Dr. T. E. Snyder and Mr. R. St. George to Savannah, Ga, in their preliminary survey of the timber and mills of the lumber company with whom co-operative investigation was proposed.

The timber consisted chiefly of *Nyssa* sp. and *Liquidambar* sp. (Sour—and Sweet—gums, respectively). The standing timber is bought by the Company and is felled and transported by them. The trees stand in swampy land, which fact limits the methods of transportation. In the hotter months the logs can be hauled by mules to the Savannah river and are floated whole to the mills, where they are either sawn at once or dumped into water tanks: this floating depends on the occurrence of "freshets" or increased flow of water due to the rains, and it is while waiting for them that the logs are attacked by insects. In other months whole logs cannot be floated and decay rapidly if left, so that the expensive method of sawing into short lengths and transportation on lighters is used.

The insects in question are either (1)*Ambrosia* beetles which make small cylindrical tunnels through the timber of almost any species or (2) certain *Cerambycid* beetles such as *Monochamus* sp. which makes large tunnels in coniferous logs. Attack by these insects makes the timber useless to the owners, match manufacturers, whose process entails veneering of the logs on large lathes.

The experiments on preventive methods such as sun-curing, spraying with deterrent fluids, water submerging, etc., should give results which after modification for local conditions should be applicable to all similar problems.

These swamp forests are peculiar in appearance as all the trees are heavily draped with " Spanish moss " (*Tillandsia* sp.). There are indications of the formerly abundant Swamp Cypress (*Taxodium distichum*) which has been selectively cut out and is rapidly disappearing as a forest tree, as its regeneration is very difficult. A similar condition as regards this tree was noticed later in New Orleans where very large swamp areas have been cleared and are undergoing reclamation processes.

Bark-beetle control in Oregon.—The last two weeks in April were spent in visiting a large scale bark-beetle control project in southern Oregon. The usual lateness of the snow remaining on the ground had retarded the commencement of operations until about the time of the writer's arrival at the end of April.

The control of the bark-beetles belonging to the genus *Dendroctonus* (*Scolytidæ*) is by far the most important problem with which the Division of forest insects has to contend. In this genus, which contains many species attacking conifers in all parts of North America and also one in Europe (*D. micans*), *D. brevicomis* attacking western yellow pine (*P. ponderosa*) is one of the most serious pests.

The genus has been the subject of detailed taxonomic and economic study by Dr. A. D. Hopkins and his results are recorded in his well-known monographs.

The writer was able to see, in Oregon, the practical application of control measures advocated by the Bureau.

The beetle in question *Dendroctonus brevicomis* is endemic in all the yellow pine forests of the west and in this State causes a continuous annual loss by hastening the death of over-mature and sickly trees which might otherwise have lasted until extraction was possible, the aggregate annual loss from this widely scattered type of attack is very great, but the really serious damage occurs when the infestation becomes epidemic and a large proportion

of healthy trees are killed and become a total loss owing to the impracticability of extracting them unless they stand in or near an area being logged. The work now being undertaken consists in the direct control of areas undergoing an epidemic attack.

As the control largely depends on a knowledge of the insect's life-history the latter may be summarised as follows : adults and larvæ hibernate in the outer bark of trees attacked in summer and autumn, and in the following spring the adults emerge and lay eggs in the bark of fresh trees. From these eggs, emerge larvæ, which kill the trees by the girdling effect of their galleries.

As a vigorous tree is able, by the resin-exudation, to resist attack, the beetle prefers to oviposit in over-mature or unhealthy trees, but when beetles are present in enormous quantities, they are able, by mass attack, successfully to overcome healthy trees and cause epidemics. The existence of beetles in very large quantities is due to the fact that considerable non-resistant breeding material, such as débris from lumbering operations or extensive windfalls, has been available.

The resulting epidemic is liable, in subsequent years, to spread over the whole forest and the prevention of this spread is the aim of the present operations.

Control consists in felling and peeling and burning the bark of infested trees to destroy the contained larvæ. This must be done before the middle of July, the period at which adult beetles begin to emerge to attack fresh trees. Infested trees occur in groups of from three to several hundred trees and are recognised by the fading of the foliage to yellow or red.

The practical application of control measures has been until lately a complicated one owing to the mutiplicity of ownership in this area : where the Federal Government, the State and hundreds of private owners have property. In the past, some owners have spent large sums in cleaning up their own areas, but lack of simultaneous co-operation by neighbouring owners has always resulted in re-infestation from the untreated areas.

The owners in Oregon, alarmed by the severity of the depredations, united to form an association for insect control. As a

result of a petition to the Congress, an allotment of $ 150,000 was made for the purpose of co-operative work by the Government in 1922. The association is responsible for the passing by the State of Oregon of the "Pine Beetle Law" of 1921 which provides that where owners of at least 60 per cent. of the timber land in an area, notify the State forester that their timber is infested, the forester may declare the whole area to be an "infested area" in which all owners are compelled to co-operate or to suffer the penalties.

In the present operations in the Klamath Falls, Oregon area, the cost is divided between the Government and private owners, the latter having their costs arranged in proportion to the area treated. The whole control work is supervised by entomologists from the Bureau of Entomology.

Details of methods used may be of some interest. In this forest three camps were set up in centres of infestation as soon as the snow had cleared sufficiently. The men are divided up into two types of crews, one for "spotting" and one for "treating."

The "spotting" crew, consisting of a compassman and two "spotters" is responsible for the surveying of the area and the marking down of all infested trees. The surveying is done in strips 5 chains wide, the spotters calling out tree numbers to the compassman who marks them on his map. The spotters number the infested trees and nail a card giving details of infestation, etc., on each tree. The compassman at the end of a day's work gives his maps to the foreman of the "treating crew" who on the following day treats the trees indicated. The training of spotters is very important as they must be able to recognise trees which it will pay to treat and avoid abandoned trees.

Treating consists in felling the trees, peeling the bark and burning it together with the piled up brush and branches. In the later part of the control season, when the fire risk is greatest, the larvæ may be killed by simply exposing the bark to the hot sun. The larvæ of some species of *Dendroctonus* as for example *D. monticolæ* do not enter the bark but remain between the latter and the work and so are exposed and killed merely by stripping the bark.

This " direct control " method is very laborious and expensive, entailing very concentrated action during the few possible months and continued maintenance of control afterwards. In the future increased interest may lead to preventive measures, as for example, cleaner lumbering and forest management.

(*To be continued.*)

J. C. M. GARDNER, I. F. S.

THE PRINCIPLE OF COMMUNAL RESPONSIBILITY IN FOREST ADMINISTRATION IN INDIA.

Often in the course of our readings of Forest reports we come across a sentence like this—village X.Y.Z. has had its grazing fees doubled for bad fire protection, or in village D.U.M. the grazing fees have been quadrupled for persistent failure in fire protection. Most of us read on hardly noticing such sentences or (if our interest is at all stirred), with a muttered remark from the depth of our easy chairs, "Serves them right, the beggars.' The fact that whole village, without exception in favour of any individual, has been thus summarily penalised moves us but little or only to a sense of righteous indignation, "Serves the beggars right."

Yet to any mind used in weighing moral values and responsibilities, such a sentence must come with a painful shock o outraged justice. For what does the sentence convey? This, that for one or more forest fires in the neighbourhood of a village, the responsibility for which it has not been possible to trace to any particular individual, *all* the inhabitants of the village without exception, are held guilty and made to suffer. The monstrosity of such an act of "justice" would be brought home to everyone of us if we could imagine for an instance that we were under the rule of a despot who, unable to trace to their perpetrators certain robberies of the King's Mail as it passed through the village where we lived, decreed that every inhabitant of the village including us, should have his taxes doubled. Yet, the imagined case, is in no way

different from the case of the villagers doomed to pay double grazing fees; if anything the comparison is unfair to the villagers, who are *all* called on to help extinguish the fires for which they have to pay the penalty of double grazing fees, though we (in the imagined case of the robbed mails on their way through our village), would not be under the obligation to join the hue and cry, in the wake of the robbers.

The fact is, that the whole theory of "communal responsibility" is wrong in principle. In no other country laying claim to the name of "civilised" would its application, even for a day, be tolerated. And, even in India, it is silently acquiesced in, only, because the solitary lesson that the dumb masses have learnt through these ages is that sad one of expecting nothing but suffering during their sojourn in "this vale of tears" and of bearing it in patience and silence.

"The people have no interest in disorder." Individuals may do wrong; but it must be an extraordinary and almost unimaginable combination of circumstances which would make the diverse elements of a heterogenous community participate, whether actively or passively, in "common guilt." Yet, on this impossible assumption, of common participation in guilt, only can the theory of communal responsibility be based. It is doubtful whether even in a primitive tribal community, the application of the principle would be just. Homogenous as such a community is, being practically an enlarged family, it still may contain, under the influence of the biological law of "variation," certain individuals who may not only not be participants in the guilt of the members of the tribe, but may actually disavow and denounce it, when they come to know of it. How much more problematic, therefore, must be the justice applying the principle to a modern Indian village where heterogeneity and a multiplicity of castes, creeds, and interests, are the general rule.

In the case of forest fires in particular, it is *not* in the interests of the forest villages, as a rule, that the neighbouring forests should burn: *they* have the unpleasant duty of extinguishing them without any extra reward Anyone who has known what terrible

work it is, to fight a fire in May under a burning sun, miles away from water, will appreciate the force of the inducement which most of the villagers have, for *praying* that Providence might avert these terrible fires. By making the villagers, without exception, pay double grazing fees for the fires, therefore, we add insult to injury, and not content with that, heap injury on top of insult: for, after all their troubles of extinguishing the fires, we assume them guilty, and make them pay as if they really were guilty.

And after all, the fires may *not* have been caused by any of the villagers of that particular village at all, 99 per cent of the fires arise no doubt through some act of commission or omission on the part of man, either through malice or culpable negligence or thoughtlessness. But to admit this is one thing; and to assume that all fires in the neighbourhood of a particular village, must be due to some act on the part of some man or men of that particular village only, is quite another thing. In fact, a very plausible case can be made against such an assumption. Everyone who has observed people in India, must have been struck how the owners are very careful to keep their own houses and compounds clean, but do so often, by throwing the dirt into the *other* man's compound. This trait is also exemplified in forest thefts (as the writer had occasion to learn), forest villagers often preferring to steal from forests near *other* villages, rather than from those, near their own. It is conceivable therefore—nay very probable—that the incendiary, bent on mischief, through ill-will, will choose, not his own village forest (which he will have to help extinguish) but some *other* forest, the responsibility for which, rests on other villagers. Conversely, villagers may be expected to be more careful about their own forests, in which they will have to extinguish a fire, and to take particular care to prevent them going on fire. If this is admitted, it will be also admitted that the probabilities are, that the responsibility for a forest fire is *not* that of the neighbouring village, but of some *outsider*. In fact, it is often the careless traveller who drops a "bidi" and starts a fire, as he goes blissfully on his way, unconscious of harm and away from responsibility.

Communal penalties would be wrong, even when the malefactor was an undetected member of the community. They are doubly wrong and unmitigatedly iniquitous in cases like those just noticed. The present practice in fact amounts to this: an offence has been committed, and a victim is wanted to expiate it; well, *the most convenient object at hand* is fastened on and led to the alter of the blood-thirsty goddess of revenge and sacrificed. The barbarous law of a tooth for a tooth, is thereby satisfied; but Justice weeps. There are not wanting officers who claim an "educational" value for the process. But the only education that can result from it, is that of angry and resentful feelings and of that mental attitude which sets the people against the Forest Department.

Fear and Hate may be bred and intensified by the process, but surely, it is not on these "educational" forces that forest administrators hope to rely for the people's co-operation. For after all, it is the people's co-operation, which is our surest weapon for fighting the fire menace. Our present idea of this co-operation is, however, a curious one: we say to the villagers in effect: Look here, I am the guardian of this forest; I am paid for protecting it; I am to see to it that it does not burn. But if it burns and I cannot find out who set it on fire—you know I have a big stick, so keep your eyes open (even if mine may doze)—unless you can show me the man who did it, I will catch you and *you will catch it.*

The Big Stick has had its uses—in the past, when man was a cave dweller and when the only argument that he could understand, was the *argumentum ad baculum*. It is no longer a fit weapon for hands, which claim to have left the stone, bronze and iron ages far behind. Modern educationists have come to recognise, that, wise as Solomen was, he never said a more foolish thing than when he gave to the world that often quoted proverb, spare the rod and spoil the child. It is now understood, that it is the unsparing use of the rod, that does the spoiling. If we want to educate our villagers, so that, ere long, they can be acclaimed as our allies in fighting and preventing forest fires and

generally in forest improvement we must follow other methods than those we have been following hitherto. We must follow in the footseps of the U.S.A. and Canadian Forestry Departments—in this, as in their methods of forest exploitation—and rely on educating the people in the real sense, by active propaganda in schools, and through lectures, lantern slides and other similar means. It may mean money; it will mean extra work but is not it worth while? The other method, the one to which we have been used, leads nowhere, unless it be to greater estrangement between the people and the Forest Department. It ministers no doubt, to that idle pride which is often bred in men "dressed in a little brief authority," and which fills us with an unthinking and often unjustified sense of self-righteousness; but, for that very reason it should be guarded against. Only so, can we hope for a better understanding and better relations with the people, on whose good will and co-operation, after all, much of the success of our efforts, in the interests of forest conservancy and improvement, ultimately depends.

D. R. Y.

UTILISATION OF SAWDUST AS FUEL FOR COOKING PURPOSES.

Although sawdust is known to be useful as fuel for household cooking purposes, it has been neglected in this part of the country for want of special stoves.

A simple stove can be made cheaply by following these instructions.

Take an empty kerosene drum of 4 gallons capacity and take off the lid. Make a small hole of about 3 inches diameter, close to the bottom, Figure 1, C.

Take two short lengths of bamboos or rounded wood to fit the hole C, Figure 1.

Put one bamboo through the hole C, reaching as far as the centre, and another through the top along the centre of the drum, making the two pieces form a right angle Figure 2, A & C.

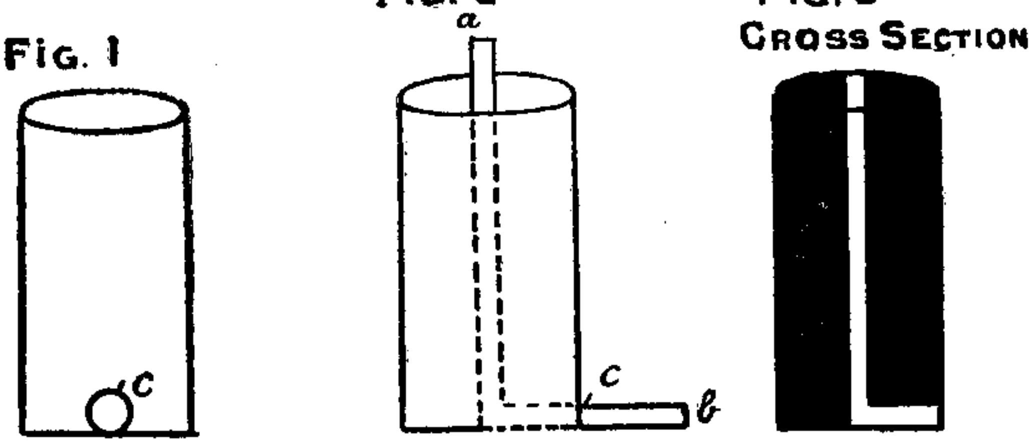
Now fill the drum with sawdust, ramming down as hard as possible. After this is done draw out the two rods A & B gently and a right angled flue will be thus formed, Figure 3.

The stove should be lit by introducing an ignited piece of bamboo or wood at hole C.

The combustion can be increased by allowing twigs or chips of wood to burn inside the hole C.

A stove thus prepared, will burn from 6 to 8 hours with constant heat, requiring little attention and apart from cheapness, is clean in use.

FIG. 1 FIG. 2 FIG. 3 CROSS SECTION



MAUNG KANTAYA,
Forest Ranger, Burma.

PLANTING PROCEDURE.

The following article is given verbatim from the Second Annual Report of the Forestry Commission for 1920-21, as it contains much valuable and interesting matter on the methods and procedure of planting. Although mainly referring to planting in the United Kingdom and not altogether applicable to the lightning methods of the Indian cooly, yet the article has many points of interest and value to Forest officers in this country.

"In view of the high costs of labour and material, the Commissioners appointed a "Co-ordination Officer" to study methods and procedure in planting operations with special reference to

securing economy in the employment of labour. The whole problem is somewhat complex, as initial cheapness does not always mean cheapness in the long run. The first cost of planting can readily be reduced, for example, by wider spacing, the use of smaller plants and simpler methods of putting the plant into the ground, but deaths, increased weeding costs and a slower rate of growth may turn the apparent gains into a loss.

In the investigation extensive use was made of the time-study method, which the following example illustrates. It was found that an unsatisfactory gang of planters, whilst planting steadily, dealt with plants at the rate of three in two minutes, or 90 per hour per man, and that each man was on the average planting 450 trees in the nominal (8-hour) working day. They were therefore doing, in effect, five hours' useful work per day, the remaining three hours being lost time. Upon further examination it was found that the three hours were occupied as follows :—

Lost time per man per day :—

(*i*) Walking to and from meals ...	40 minutes.
(*ii*) Walking time (between finish of one line and commencement of next)	30 „
(*iii*) Time (additional to *ii*) spent in setting pickets to assist in keeping lines straight	30 „
(*iv*) Delays at beginning and end of lines	30 „
(*v*) Various delays (waiting for plants, resting, smoking, talking, etc.) ...	50 „
	3 hours.

"The above items were then attacked singly and waste eliminated so far as possible, *e.g.*, a portable shelter allowed the men to take their meals near their work, they were trained to work without pickets, and so on.

"Having thus secured that the maximum time is spent in useful work, it remains to secure that operations are carried out at the highest possible speed compatible with good work.

analyses by means of a stop watch reveal the percentage time spent on each phase of an operation, and can be employed to ensure that increased speed is not obtained merely by scamping any one phase. An example from an analysis of planting work illustrates this point. In most planting operations there are four phases :—The removal of the turf, the opening of the ground, the insertion of the plant, and the firming ; then, after the time spent in taking up a position for the next plant, the cycle recommences. The following times for the best and worst men of a gang judged by the quality of their work are interesting :—

TIMES PER PLANT : (Seconds).

	Surface Preparation.	Opening Notch.	Inserting Plant.	Firming Plant.	Walking.	Total.
Best Man ...	9·4	5·7	5·3	4·9	15·7	41
Worst Man ...	7·0	6·1	3·2	2·8	21·9	41

"It is obvious that the worst man was taking his time between plants, and therefore had to scamp the planting work in order to keep pace with the gang. Observations of this kind over a hundred or more plants, also enable different planting methods to be critically compared. In doubtful cases, *e.g.*, whether it is better to remove turf at time of planting, or previously, time-analysis figures can be used to determine the relative cost."

"The main operations reviewed have been nursery work, planting and preparation of ground (for planting).

"*Organisation for Planting.*—Under the methods of planting commonly adopted by the Commissioners, and under average conditions, the best results are secured by dividing the planters into small self-contained units, of five to ten men under a responsible leader or "ganger," with boys (two or three per gang) to keep the men supplied with plants. The latter then give their full and undivided attention to the actual planting ; the boys fetch bundles of plants from small dumps (one every two or three acres) established in advance, and supply plants

to the planters as required, meanwhile carefully protecting the bundles so that the roots do not become dry. Except in the early stages of an operation, all cumbersome aids to accurate alignment and spacing are dispensed with. Inexpert labourers if well led, rapidly learn to keep the rows sufficiently straight and to keep the error in the number of trees per acre below 5 per cent. ; the expenses of greater accuracy can only be justified, when a corresponding reduction in weeding, cleaning, or extraction costs, is anticipated. The planting organisation most generally adopted, is that in which the planters advance in echelon ; a good man leads the gang, judging his direction and spacing from a line of planted trees, which he parallels, other workers following behind, each man one row further over than and one plant behind his neighbour. If the ganger is on the rear flank of the gang he can supervise and control the work of each member."

"*Size of Plant.*—The Commissioners commonly employ small transplants (three or four years old) and the resulting advantages, such as fewer failures and lower cost of plants and planting, are considered to counter-balance any additional costs involved in the preparation of ground and in the subsequent tending of the plantation. It is noteworthy that in one area, where very steep hillsides are being planted, the cost for distribution of plants, from nursery to planters, was reduced from 6*s.* per acre to 6*d.* per acre by the substitution of small for large plants, the smaller plants having, if anything, succeeded better than the larger."

"In clearing ground for planting the tendency for men on day work is to overdo the clearing. It is found that men generally work best in gangs of, from three to six, working in parallel swathes, and burning (if weather is favourable) as they cut. It is essential that workers appreciate, and work to (without exceeding) that precise degree of clearing judged necessary, in consideration of the size of plants to be used, and similar factors."

"*Spacing of Plants.*—The faster-growing species, in good situations, are generally spaced six feet apart, spacings of from five to five and a half feet predominate, whilst in poorer situations,

and with Scots pine or Common spruce, four to four and a half foot spacings are usual. It has been considered that, with the wider spacings, any loss in the quality of the timber is offset by the reduction in initial expense and in the cost of early thinning operations."

"*Method of Planting.*—Under existing conditions it appears, that the use of the cheaper planting-methods such as dibbling and notching (with spade or mattock) results in a saving on labour-costs which more than equals such gain from enhanced growth or reduction in subsequent tending costs, as might result from a more elaborate planting method ; the main exceptions to the rule occur in places where, if a better planting-method be adopted the cost of preliminary preparation of ground can be correspondingly reduced. In many cases the percentage of failures attributable to inefficient planting has been negligible and better results could hardly have been achieved, no matter what planting method had been used, whilst in others the increased cost of a better planting-method would not have been justified by the resultant reduction in beating-up costs. Experience has emphasized the importance of conducting carefully arranged experiments to determine for each area the most suitable planting-method and the precise pattern, shape and weight of tool to be used, and of instructing planters in their use. Many of the tools on the market are not suitable for efficient planting work, while custom often stands in the way of introducing tools more suitable than those locally in use."

"*Nurseries.*—In nursery work savings have been effected by employing the best of existing tools, by the introduction of labour-saving devices, and generally by the more careful handling of plants. The advantages, both as regards quality and quantity of work, of the transplanting lath for lining-out in suitable soils, have been amply demonstrated, the use of wheeled cultivators is now almost universal, and the use of the plough is increasing. As in the case of clearing ground for planting, there is frequently a tendency to overdo certain nursery operations such as weeding."

"*Piece-work.*—The above remarks refer mainly to estates where day-labour is used ; experience shows, however, that almost all forest work can more economically be done "piece-work" or contract. This especially applies to fencing preparation of ground for planting, and the lining-out of seedlings ; even notch-planting has been successfully done by piece-work and it appears that if the work is efficiently supervised its quality does not suffer but, on the contrary, may even be improved ; this may be attributed to the workers' additional care, lest they should be made to rectify unsatisfactory work without remuneration."

H. TROTTER, I.F.S.

EUCALYPTUS OIL.

History and Introduction.—The distillation of Eucalyptus Oil in the Nilgiris dates as far back as 1860, when the first plantations were started by a few European settlers. Since then the industry has been increasing in importance for various reasons and a good market for the oil is on record. The particular genus *E. Globulus* or the Blue gum, is the variety found in abundance on the Nilgiris. This is pre-eminently suitable for the distillation of the best Eucalyptus oil in the British Pharmacopœia. Nevertheless a good deal of Australian oil is imported for consumption in this country. The following account, it is hoped will not only review the present position of the Industry in the Nilgiris, but also indicate certain lines of future development.

The Distillation of Oil.—The distillation of oil was first started on a small scale by a few European settlers about 50 years ago. At present a little more than 2,400 lbs. of oil per year is distilled and sold. The general rule has been that any man having a small Eucalyptus plantation of his own has erected a small distillery, using the leaves obtained from his own estate. At present there are five planters engaged in the Industry. In addition to this, there is a small still producing 3 lbs. of oil a day, in the Government Botanical Gardens, Ootacamund. These firms obtain the major portion of their leaves from private estates and the rest from the Government plantations. The Ootacamund oil is not generally re-distilled, except by one of the firms (Manager, Mr. Brown of the Felixstowe Laboratory). Others who tried re-distillation have not had much success, owing to the faulty type of plant employed, which resulted in a loss of more than half the oil.

Leaf Supply and Cost of Production.—The chief consideration in the way of a greater expansion of the industry is the question of leaf supply. In Australia, the distillation of the oil is a great success on account of the maintenance of a constant leaf supply by adopting the "lopping" system. This system has been found impracticable on the Nilgiris. The only other possibility, is the starting of special plantations on short rotation for the purpose of a regular supply; the fuel being of secondary importance.

The quantity of leaf that can be made available at present can be found by a simple calculation. Taking roughly, 2,400 lbs. of oil as the annual output from Ootacamund, and 8 per cent. as the average yield of oil, the total quantity of leaves consumed by different distillers come to about 1,300 tons per year. The total acreage under Eucalyptus is 1,914 acres. The total yield, calculated according to the exports carried out by the Forest Department is five tons per acre. So that, if all the trees are felled, there should be available 9,570 tons of leaves. As a matter of fact, however, the forest revenues per annum for Eucalyptus leaves removed is only about Rs. 200. Taking 8 pies per 200 lbs. of leaves that the distillers pay for them, it seems that out of the 1,300 tons used only about 450 tons are obtained from Government felling acres, and 850 tons from privately owned plantations. Since lopping cannot be adopted with advantage, attempts must be made to start fresh plantations for the supply of leaves. The cost of production is as follows:—

	Rs.	as.	p.
Cost of leaves, 200 lbs.	0	0	8
Cost of collection	0	6	0
Carriage	0	8	0
Interest on actual outlay	0	4	4
Total ...	1	3	0

The yield per acre 200 lbs. is $27\frac{2}{3}$ oz. The sale price for this is Rs. 2. So there is a profit of about 12 as. per 200 lbs. of leaves. This is the general cost of production. The following is the cost of production by Mr. Brown, who was kind enough to place the following figures at the writer's disposal:—

	Rs.	as.	p.
Cost of production $11\frac{1}{2}$ lbs. (Without transport of leaves)	0	10	0
Transport of leaves	0	2	3
Cost of bottles, minor expenses, etc. ...	0	3	9
Total cost for $11\frac{1}{2}$ lbs. ...	1	0	0

The oil is usually sold at from Re. 1-10-0 to Rs. 2.

The profit per bottle of 1½ lbs. is 10 to 12 as.

The Nilgiris distillers get a profit of 6 to 8 as. per lb.

The wholesale price at which Australian oil is imported into India is about Re. 1 per lb., a price which the Nilgiri oil fetches. The quotation for Eucalyptus oil in London is Re. 1-4-0 to Re. 1-5-0. The cost of transport from an Indian port to London is not more than 1 to 2 as. per lb. of oil. It is, therefore, safe to take the lowest estimate of Re. 1 per lb. as the maximum sale price of the Nilgiris oil, in order to calculate the commercial possibility of the Industry. In order to sell larger quantities of oil to the wholesale dealers, and in view of the extremely low prices of imported Australian oil, it will be eventually necessary for the Nilgiris distiller to reduce the cost of production to such an extent as to be able to sell the oil at a wholesale price of as. 15 per lb. at the distillery, or at Re. 1 per lb. including the cost of packing, tins, etc., at Calcutta or Bombay.

Future Prospects.—Developments of the industry on more profitable lines.—In spite of so many favourable circumstances, the fact stands, that a good deal of Hashaban is still imported into this country, showing that the Industry has not been fully exploited. In this connection a series of experiments carried out by Mr. Puran Singh, Forest Chemist, Research Institute, Dehra Dun, are found extremely interesting. These experiments were carried out with a view to work out the various factors that will contribute to the economy of the Industry.

Semi-commercial distillations were carried out on the spot, and as the result of a series of experiments, he came to the conclusion that much depended upon the nature of the leaves. While the best yield of the ordinary Nilgiris distiller is 1·4 per cent. of oil calculated on the weight of the dry leaves, by using the mature leaves drawn from trees planted so late as 1873, the yield obtained was 2·28 per cent. Thus the distillation of such mature leaves is recommended as a first step. The initial outlay of capital on mechanical contrivances calculated to reduce the cost of transport

of leaves is recommended in preference to making arrangements from time to time and dealing with unskilled and half-hearted labour obtainable on the Nilgiris. This refers to details of organisation, which an enterprising manufacturer can easily overcome, and thus secure permanent reduction of his recurring charges of transport. The design of the still recommended for adoption is of iron lined with copper. A catch still will serve the purpose of holding back impurities, and the very heavy *sesqui*, thus giving even in the first distillation a very good oil and avoiding redistillation. The leaf supply ought to be increased by starting special plantations on a very short rotation, the resulting fuel being of secondary importance. To make it a profitable industry it must be worked on a sufficiently large scale (about 2 tons of leaves per day).

Working Costs.—On the above lines, taking a factory of two stills each with a capacity of one ton dried leaves to be worked alternately by a 30 N. H. P. boiler, the following, initial costs will have to be taken into account :—

OUTLAY.

	Rs.
Boiler and accessories	8,000
Two iron stills, copper lined ...	6,000
Sheds, etc.	7,000
Other charges	4,000
Total ...	25,000
Interest at 6 per cent. on Rs. 25,000 at Rs. 125/ per month	1,500
Depreciation at 10 per cent. on plant ...	1,400
Depreciation on buildings, sheds, etc., at 10 per cent. per year or Rs. 58-5-4 per month	700

Such a factory can easily deal with 4 tons of leaves per day, 100 tons per month of 25 working days. This should produce about 3,300 lbs. of oil per month taking the yield at 1·39

per cent. This on 3,300 lbs. of oil, the depreciation and interest charges come to Rs. 299-15-6, or about 1 as. 7 pies per lb.

The supervision charges may be put down thus—

		Rs. per month.
Manager and Engineer	... ...	200
Two drivers, a maishis at Rs. 30	...	60
Two firemen at Rs. 15	... ...	30
24 coolies at Rs. 10	... ...	240
Clerk and time-keeper	... ...	40
Miscellaneous ...	... ...	30
Total	...	600

This on 3,300 lbs. works out about 3 as. per lb. The royalty on the leaves paid by the distillers is quite the right figures of 5 pies per lb. of oil.

The total cost of production at present comes to about 10 as. 8 p. per lb. of oil but as shown above, by a more efficient organisation of collection and transport, the figure could be brought down as follows :—

	Rs.	as.	p.
Cost of leaves (Royalty)	0	0	5
Cost of lopping and collection ...	0	1	4
Cost of transport for a distance of five miles	0	1	8
Packing	0	0	3
Fuel	0	0	6
Supervision	0	3	0
Interest and depreciation ...	0	1	5
Total ...	0	8	7

In comparing this figure with those given by the Nilgiris distillers (10 as. 8 p. per lb.) account has not been taken of interest on capital, depreciation, supervision charges, which might be put down at about 4 as. Thus the total cost will come up to about 15 as. for the Nilgiris distiller. If the sale price of the oil

went as low as 11 as. per lb. at the factory, a net profit of 2¼ as. per lb. could be secured. If it is sold at Re. 1 at Bombay or Calcutta it will fetch a net profit of 7 as. 5 p. per lb., also it will probably capture the foreign markets and thus stand a fair chance of competition with the Australian oil. Such an oil very well satisfies the tests of the British Pharmacy.—*(Industrial India.)*

NEW TANNING MATERIAL.

INVESTIGATIONS IN WESTERN AUSTRALIA.

The world shortage of vegetable tanning materials, has for some time past been a cause of some anxiety in the leather trade. The natural materials are being rapidly depleted. Mallet bark (Western Australia) has fallen from an export of 155,000 tons (1906) to about 5,000 tons (1920) owing to the cutting out of supplies. Wattle bark is now being imported in Australia, the home of this material, from the plantations of Natal. The hemlock of U. S. A. has almost entirely disappeared from commerce to be replaced by chestnut, oak, and quebracho. The former is estimated to be disappearing five times quicker than regrowth takes place, and the latter (from South America) is being slowly cut out.

Any considerable increase in the supplies of the older cultivated tanning materials cannot be expected, and, apart from the cultivation of (Australian) wattles in South Africa, no new materials have been cultivated. Consequently, there is a unique opportunity for the forests of the Commonwealth to provide a supply of tanning materials. When the amount of forest country cleared every year is considered, the quantity of bark alone which is destroyed in this clearing is seen to be enormous. Similarly the sawmills destroy much bark. From these two sources alone it appears that there might be obtained a regular supply of tanning material which would turn to good account a product at present of no value. The virgin forests must hold vast quantities of valuable tanning materials which with proper working, will provide a regular supply for many years.

Cultivation of such tannin-bearing trees as are valuable may prove a sound policy, and the late Conservator of Forests of Western Australia (Mr. Lane-Poole) has planted cut-out mallet country with mallet seed. Should this experiment be successful, a valuable addition to the tanning resources of the Commonwealth will be possible, especially since the usual rough ironstone country favoured by mallet is unsuitable for agricultural purposes. And the lesson learned from the mallet bark exploitation should not be forgotten when new tanning materials of commercial value are discovered.

A comprehensive investigation of the tanning materials of Western Australia has recently been completed by the Commonwealth Institute of Science and Industry in co-operation with the Western Australian Forestry Department. This investigation has been carried out by Mr. H. Salt (Leather Chemist to the Institute), and the results of the work have now been made available by the Director (Mr. G. H. Knibbs). The total number of materials examined was 170, the analyses being carried out in accordance with the official standard method adopted by the Society of Leather Trades Chemists. The object of this survey was to form an estimate of the tanning value of the forest materials of Western Australia, and some very valuable results have been obtained. The barks of gimlet wood (*Euc. salubris*), karri (*Euc. diversicolor*), and ridge gum (*Euc. alba*) are examples of barks formerly regarded as waste materials which are rich in tannin and are excellent as tanning materials. Gimlet wood is very common throughout the State, and considerable quantities of this wood are burned every year in clearing and as firewood. The quantity of bark included in this destruction is very great. Karri, of which 300 loads per day is an average cutting, has a thick heavy bark containing 20 per cent. of tannins that make a supple and good coloured leather. Ridge gum (known as mountain gum in Queensland and as river gum in Java) can be obtained in huge quantities in the north of Western Australia. This bark contains upwards of 30 per cent. of an easily soluble tannin. Two of these barks have been tried in tanneries on a

commercial scale on the suggestion of the Institute and have been found to give excellent results.

As an example of the money which can be saved by making use of these barks, karri is perhaps the most interesting, being one of the best-known Western Australian trees. The cutting of 300 loads of karri timber per day indicates what quantities of bark can be stripped from the timber alone, but when the amount left in the forest on the rejected portion of the tree is included in the estimate of tanning material available, 20 tons per day could easily be obtained. This bark is at present worthless and consequently in manufacturing a tanning extract the raw material will only cost the price of collection. The working of the tannins into an extract would entail labour costs and carriage to a port. Where karri is cut there is an ample supply of waste wood for fuel and water is plentiful. Consequently the actual cost of production of a karri tanning extract would be very low. Since 20 tons of karri bark will make 5 tons of karri extract, having a value of about £25 per cent. it can be readily seen what possibilities there are in this bark alone.

The barks, of which particulars are given in this article, occur in sufficient quantities in Western Australia to warrant their use as tanning agents in this State, but some are not sufficiently plentiful to be a regular source of tanning extracts. However, considering these barks together, there appears to be a future for the manufacture of mixed tanning extracts, that is, extracts in which are incorporated the tannins of two or more barks. By suitably blending the materials available in Western Australia, many of which are destroyed in clearing, etc., the manufacture of a mixed extract should be a commercial success. Such materials as were considered of value are included in the following list with their average tannin content and with particulars of distribution :—

1. *Acacia acuminata*, containing from 7 to 15 per cent. tans in mature bark. *Acacia acuminata*, or raspberry jam wood, is so called on account of the smell of crushed raspberries in the newly-cut wood, a smell which is

present in the extract from the bark. The tree is plentiful over a large area and occurs in large patches, "jam" country being usually good grass land. The mature tree is from 15 to 20 feet high, and the bark is about ½ inch thick. The branches are used for fencing posts as they apparently immune from the attack of white ants. The liquor obtained from the bark gives a precipitate on standing. The leather made by using this liquor is a light colour, and in general tannery practice would give a light leather suitable for dyeing.

2. *Acacia microbotrya*, containing from 18 to 27 per cent. tans, known as badjong, black wattle, or manna wattle. The leaves and twigs, of which one sample was available, showed a tannin content of 20 per cent. The tree is called manna wattle on account of the manna gum it exudes. It is found scattered over a large area usually associated with *Acacia acuminata.* The height of the tree is about 15—20 feet and the bark is about ⅓ inch thick.

3. *Acacia decurrens*, containing 39 per cent. tans. This is a "wattle bark"; the tannin content is good. The success of an experimental plantation at Balingup warrants further sowing.

4. *Acacia salicina*, containing from 6·5 to 7·5 per cent. tans, is a shrub growing in the Western Australian gold fields districts, and is very plentiful in the country between Southern Cross and Kalgoorlie. This material, along with other shrubs, is being worked for tanning with the ultimate object of manufacturing a mixed tanning extract with the gimlet and salmon gum barks from the firewood used in Kalgoorlie. The admixture of the two latter will have the effect of increasing the ratio of tans to non-tans. Leather made from these materials is of a very light shade.

5. *Callitris calcarata*, containing 17·0 per cent. tans, is the bark from a wood of which a sample was forwarded by the New South Wales Forestry Commission.

6. *Eucalyptus accedens*, containing 18 per cent. tans, known as potted gum or powder bark wandoo. This tree is found scattered among wandoo, particularly in the ranges between Midland Junction and York. The height of the tree is 30 feet and the bark is about ½ inch thick.

7. *Eucalyptus alba*, containing from 30 to 32 per cent. tans. This is the ridge gum of the Kimberleys, called the river gum in Java and the mountain gum in Queensland. It grows to 35 feet and the bark is about ½ inch thick, white outside and pink inside. The tannins present are readily soluble in water and mostly at a temperature below 50 degrees C. It is found throughout the north-west of Australia. The tree often has a twisted trunk and the wood is very hard, but up to the present no use has been made of the timber. The Department of the North-west is using this bark on the aborigines stations at Moola Bulla, 270 miles south of Wyndham, and though the apparatus is primitive and the labour mostly native labour, they have turned out excellent leather of a good colour and substance. The quantity of bark available can be said to be unlimited and the stripping is easy. The difficulty is transport to the coasts, but this could be overcome by proper organisation. It grows in hilly districts and is a prolific seed bearer, consequently regrowth is natural. Seeds grown at Hamel (south-west of the State) have given excellent results. Besides the value of this bark for export or for extract manufacture, the supply of cheap hides in the Kimberleys offers an opportunity of establishing a tannery in or near the source of the Ridge gum supplies.

The map showing the distribution of *E. alba* only indicates areas definitely known. That there are supplies in other areas is certain, and round Nullagine there is a district rich in this species, but its extent is unknown.

8. *Eucalyptus diversicolor*, containing from 16 to 20 per cent. tans, commonly known as karri. The wood of this tree is much used for sleepers in Western Australia and many other parts of the world, and as a timber for shipbuilding and structural work. It commonly grows to 250 feet and more, and frequently the first branch is 100 feet from the ground. The bark is $\frac{3}{4}$ inch thick. The average daily cutting of this wood is 300 loads from which the bark is burned as waste. The leather made from the bark extract is a pale cream in colour, darkening to a pale brown on exposure to sunlight, but the final colour is still good. The rate of penetration of liquors is rapid, a piece of kangaroo skin being tanned through in two days, drying out to a tough supple leather A local tannery has used karri in making several sides of sole leather and found it to have the characteristics found in the laboratory tannages.

9. *Eucalyptus erythronema*, containing 30 per cent. tans, known as white mallee. This tree, which has the general mallee formation, grows from 10 to 15 feet high and bears a thin bark. It is found in areas where *E. salmonophloia* and *E. salubris* are common, and is commonest in the Avon district where it grows in thickets. The extract from this bark is pale in colour and gives a pale coloured leather, a property which appears to be common to mallee barks generally.

10. *Eucalyptus falcata*, containing 32 per cent. tans, known as white or silver mallet. This is a tree growing up to 4 feet high with a thin bark often containing kino. It is scattered in mallet patches and is not plentiful, but is stripped and sold as "mallet."

11. *Eucalyptus loxophleba*, containing from 5 to 10 per cent. tans, known as York gum. Although this bark has not a high tannin content it is very plentiful over a wide range. The tree grows from 40 to 60 feet high and the bark is ½ inch thick. York gum is extensively used for waggon wheels and in cabinet making.

12. *Eucalyptus occidentalis*, containing from 20 to 26 per cent tans, known as swamp yate or black mallet. This tree grows to 50 feet high, carrying a bark of about ⅓ inch in thickness. It is found in clumps in swamps and other low-lying places in the south.

13. *Eucalyptus occidentalis*, var. *astringens*, containing from 40 to 56 per cent. tans, commonly known as mallet, brown mallet, or red mallet. This tree grows up to 50 feet high, and has a thin bark which is very easily stripped. It is found in thickets of up to 10 acres in the area described in map. Its natural habitat seems to be the ironstone ridges, but farther south the mallet patches are found on the lower flats. The mallet bark from the northern portion of the area is darker than that from the south, and this latter often assumes a white or flesh-coloured tint on the outside.

The mallet bark exported from Western Australia is often a mixture of the several mallets. *E. falcata* (white mallet or silver mallet), *E. redunca* var. *oxymitra* (blue leaf mallet), *E. spathulata* (swamp mallet or black mallet), and merritt (mentioned above) are all collected as "mallet." The first exports of mallet bark were very small, but within a few years the value of the export had risen from about £200 in 1902 to £160,000 in 1905, having now fallen again to £23,000.* Most of this bark had found its way to Germany. When exports began to fail, as a consequence of lack of

* This figure (£ 23,000) is the highest for many years, and seems to be the result of the low price of wool, which has caused farmers to look round for other sources of revenue. A considerable drop in next year's figures may be expected.

supplies, it was discovered that the Government had received nothing, and the strippers and exporters very little of the value of export. Not that the bark was obtained cheaply; so attractive was the business that trees of less than the regulation size (9 inch circumference) were stripped, and even the suckers were not spared. As a result, the mallet is temporarily cut out. When trees were stripped, it seems to have been usual to strip to about the first branch and then no further leaving behind a considerable quantity of bark.

14. *Eucalyptus platypus*, containing 25 per cent. tans, known as round-leaf moort. *E. platypus* grows 25 feet high and bears a thin bark. It is found in very dense thickets up to 30 acres, and the range is small, stretching from Gnowangerup eastwards, the eastern boundary not being known. The leather made from this material is the lightest in shade of all the samples tanned.

15. *Eucalyptus redunca*, containing from 16 to 20 per cent. tans, commonly called wandoo, grows to 80 feet high, and carries a bark of ¾ inch thickness. Wandoo is extensively used in building railway carriages and for wooden wheels. It is found scattered over a wide range. Stripping is difficult, but the bark is thick enough to be knocked off in large pieces when struck sharply. The extract from this bark is of a deep orange colour.

16. *Eucalyptus redunca* var. *oxymitra*, containing from 22 to 30 per cent. tans, know as blue-leaf mallet. This tree grows to 25 feet high, and bears a thin bark. It is not very plentiful, but is found associated with brown mallet. It is stripped as "mallet."

17. *Eucalyptus rostrata*, containing 16 per cent. tans, known variously as river gum (Kimberley), red gum (Victoria and Goldfields), and blue gum (Geraldton). *E. rostrata* grows from 30 to 50 feet high, and carries a bark about ¾ inch thick. It is found along watercourses, but is not very common.

18. *Eucalyptus salmonophloia*, containing from 8 to 13 per cent. tans, known as salmon gum, is very common and grows in forests. A mature tree is 60 to 80 feet in height and the bark is thick, having (in many cases) a salmon pink shade. The wood is of no value for tanning, but is useful for other purposes, being the second hardest timber of the State.
19. *Eucalyptus spathulata*, containing 26 per cent. tans, known as swamp mallet, grows from 20 to 30 feet high, and bears a thin bark resembling mallet, which strips easily. It is not very common.
20. *Eucalyptus salubris*, containing from 16 to 19 per cent. tans, commonly called gimlet, on account of its twisted trunk, grows from 40 to 60 feet high, and bears a thin kino-impregnated bark, brown outside and easily stripped. It is found associated with salmon gum in the Avon and Coolgardie districts, where it is plentiful. It gives a full leather of good colour, although penetration is slow. It has been used in local industry where wattle and mallet barks have been used, and was found to give an improved colour, with less darkening on exposure. The chief objection to its use was that it gave ropy liquors, a difficulty that might be overcome.
21. *Eucalyptus torquata*, containing 17 per cent. tans, the so-called Goldfields flowering gum, grows 15 to 20 feet high, and bears a bark ½ inch thick which is somewhat difficult to strip. It is found scattered throughout the Goldfields in small clumps. The tannin present penetrates hide fairly rapidly, giving a soft, tough leather. *E. torquata* is prized as an ornamental tree.
22. *Hakea glabella*, containing 18 per cent. tans, grows up to 15 feet high, and bears a bark ⅓ inch thick which is difficult to strip in summer. It is plentiful in thickets throughout the south-west of the State. It gives quick penetration and a pliable leather.

It seems only reasonable to assume that a similar survey of the other States will result in new materials being found that could be profitably worked. It is a well known fact, of course, that at the present time, wattle bark for tanning is actually being imported into Australia, the home of the wattle. The tannin survey of the whole of the Commonwealth will probably lead to the discovery of new sources of tanning materials, with a consequent reduction of imports from abroad. The Director of the Institute of Science and Industry is accordingly in communication with the Forestry Departments of the other five States with a view to obtaining their co-operation in carrying out an investigation similar to that which has been carried out in Western Australia. In the case of Victoria and Tasmania, this investigation has already been commenced.—[*The Australian Forestry Journal, Vol. V, No. 8.*]

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PIONEERS OF THE FOREST DEPARTMENT IN BURMA.

Burma readers of "The Forests of India" by Stebbing would doubtless be interested in the original documents from which the information concerning the early operations in Burma was extracted and a volume entitled

"Selections from the records of the Bengal Government."

No. IX.

"*Report on the teak forests of the Tenasserim Provinces*" *by* "*H. Falconer, M.D., F.R.S., Superintendent of the Honorable Company's Botanical Gardens, Calcutta*" is now preserved in the office of the Chief Conservator of Forests, Burma, from whom it may be borrowed by *bonâ fide* enquirers.

As a sidelight on the procedure in the fifties, it is interesting to note that this 1852 publication was published by F. Carbery, Military Orphan Press, Calcutta. Whether the printing was done by military orphans is not clear. If it was, then there is no doubt that they were better at the printing and publishing game, than up-to-date Government presses since the printing and general get-up are unimpeachable.

2. At the risk of being accused of plagiarising Stebbing a few extracts from the Selections may be repeated. As stated by Stebbing, Dr. Wallich, Superintendent of the Botanical Gardens, Calcutta, was deputed in 1827 to examine and report upon the botanical features of the Tenasserim Provinces and while he was at Moulmein, he was also ordered to take advantage of the opportunity "*to acquire the fullest and most complete information*" of the resources of the country in regard both to "*botanical science and military and commercial objects.*" He left Moulmein on the 10th of March 1827 and submitted his report on the 25th of April following, so that if he carried out in full to his own satisfaction the orders which were given to him, he appears to have been something of a hustler or an optimist or both. His report was written in the Secretariat style of the period, but it suffers from what might possibly be looked upon as a defect to-day in that he never used a short word where a nice long one would do. For instance, Wallich never visualised a large tree as a large tree, but he saw in it "a forest tree of very considerable dimensions."

3. Dr. Wallich's tour took him 40 miles up the Salween and later he went up the Ataran river in a gunboat "*penetrating the country to a distance of hundred miles*" accompanied by Capt. Montgomery of the Madras Artillery. As one would expect from the time of the year, jungle fires were numerous and the fires in the reed covered plains near the river are graphically described as follows :—

"*The massive volumes of smoke far and near, and sometimes to an awful height, bore ample testimony to the fact of a scorching sun and the diligence with which the scanty population are endeavouring to rid the ground at once of jungle and of wild beasts.*"

4. Considering the time at his disposal and the difficulties with which he had to contend, the report was marvellously good and probably few men would be able to collect so much information in so short a time. Dr. Wallich's recommendations which are fully detailed in Stebbing would, if they had been accepted and carried out, have made a tremendous difference to the future of the then existing teak forests in Tenasserim. His opinions on

such subjects as reservation and fire protection are extremely interesting in view of present-day conclusions. (For instance the quotation at p. 134 in "The Forests of India.") Wallich was not alone in considering that fire was unlikely to do any essential harm to teak forests, as a P. W. D. officer, one Capt. Latter who was appointed as a Forest Officer some twenty years later, wrote as follows on the subject of fire: "A tree full of sap and green vigour requires a regular roasting before it will succumb; with such the fire does little more than flicker up the trunk, licking off the dry moss and unsightly parasite. * * * In the wide extent of forest I have visited I have never seen a single instance of a healthy and sound plant permanently injured by the fires. Again, if we take into consideration the fact that every tree brought into the market is killed and allowed thoroughly to dry and season for three years, and is in this state exposed, *standing*, to the attacks of three successive conflagrations, and that few bear the slightest marks of fire, it will be evident that the destructive effects of annual fires have been much over-estimated. I cannot but think therefore that money expended in the prevention of the attack of these fires will be thrown away—the more so, that taking into consideration how rapidly a dense and stifling underwood springs up in this climate it is probable that so summary an admission of ventilation, just before the setting in of the rains, is highly beneficial to the nobler plants of the forest." Stebbing remarks that Wallich touched "*with an almost intuitive foresight on problems*" which were later to influence the management of the forests in Burma. One might almost go further and say that many of the truths we have proved at enormous expense and trouble were commonplaces with Wallich and his contemporaries nearly a century ago.

5. All the Government of India appears to have done as the result of Wallich's report, was to order the Commissioner, Tenasserim Provinces "to hold the forests as Government property and to protect from depredation or injury by private individuals." But the Commissioner apparently did not think this was quite good enough and in December 1827 he suggested working the

forests, allowing individuals to cut teak trees of 4 feet girth and upwards subject to a royalty of 15 per cent. The royalty was to be taken either in money or in kind, valuation being settled by two arbitrators. This recommendation was not sanctioned till 1829, until a sale in 1828 of departmentally extracted logs in Calcutta had ended in failure; but in 1833 a staff consisting of one headman and "8 *to* 10 *coolies*" were sanctioned for the supervision of the working of teak licensees and for planting teak seedlings. As a result of a report by Dr. Helfer from the point of view as to whether the forests were worth spending any money upon, a P. W. D. officer, one Capt. Tremenheere of the Bengal Engineers, was appointed to the P. W. D. in Tenasserim as an executive officer, who in addition to his duties in that department was to be in charge of the Government teak forests. His duties became too heavy and in 1841 the Commissioner took the law into his own hands and in anticipation of sanction appointed as Conservator on Rs. 750 a month one Capt. O'Brien. (In those days apparently even Commissioners kicked over the financial traces.) Capt. O'Brien started a new set of rules, one of which was that the minimum girth of trees felled under licenses was to be raised to 6 feet in girth measured at 10 feet from the ground. Possibly Capt. O'Brien was abnormally tall. At any rate his successor the next year ordered the girth to be taken at 4 feet from the ground. One of the other conditions was that "*five young trees of a proper size shall be planted by the farmer or by Government at the expense of the farmer.*" The lumber companies, however, apparently did not take very kindly to the last rule and it became necessary to start nurseries on Government account.

6. Capt. Tremenheere was evidently something of the Silviculturist, for he noticed the thick pericarp of the teak seed and actually tried experiments with a view to expediting germination by soaking the seeds three hours in warm water.

Sad to say, of 22,000 teak seeds planted in one year (and reading between the lines it is certain that there were subsequent sowings) only one solitary seedling was recorded. The failure

to get germination gave the experts of the day a great deal of trouble. Probably the most original explanation which has ever been offered was that of Capt. Latter who went to some pains to investigate the reproduction of teak and writing in 1848 he argued as follows :—

"The grand mode by which teak propagates itself is by seed. I have never seen a single case of a sapling shooting from the root; and in the Thoung-yeen only in a few cases where the soil was adapted for a vigorous vegetation, have I seen the stump that had been left of a felled trunk sending up shoots. The first spot on which I saw young teak in any abundance was half a day's march beyond the Meplai village; and after a careful examination of the locality, I found that they were evidently from the seeds of some partially decayed trees which had been left standing; and in every other case in which I met with young teak, I found that their presence could only be attributed to a similar cause. This is a very singular fact, but it is almost more singular how it explains many points, which appeared so difficult of solution, in reference to the self-propagation of teak. It is a remarkable circumstance that whenever I found a great number of fine vigorous and sound full-grown teak trees, I never saw any seedlings near them. But where these fine sound trees had been cleared away, and here and there some old deformed trees, or trees decaying from being covered by creepers, or with the large holes in them, etc., etc, existed, I found them accompanied by vast numbers of seedlings. It would thus appear that with the mature trees injured in their growth, or trees progressing to palpable decrepitude, the vegetative force of nature not being called away to the formation of woody structure or to the support of a large mass of substance, is directed to the effectual development of the seed. So striking is this fact, that one might almost think the plant gifted with volition, and that, conscious of the decay, it hastened ere it disappeared to shed its representatives around it. I do not mean by this to say that a teak tree in its prime does not produce seeds; on the contrary it does so in abundance, but they never come to anything until the individual shall have reached the decadence of such prime."

On the assumption that his deductions were correct, Capt. Latter explained the failure of all artificial sowings as being due to the fact that the nurseries were selected in a certain locality "because from the magnificence of teak trees on it, the ground was argued to be peculiarly favourable to the plant, but what I have already pointed out, is the fact of seedlings not being found in the immediate presence of vigorous trees will show that this was just the very reason why it ought to have been shunned." The errors into which Capt. Latter fell were very soon discovered as the historian in 1851 notes that happily Capt. Latter was mistaken and that germination under proper conditions was easy. Dr. Falconer in 1851 prescribed what was in his opinion, the best method of making plantations, and it is interesting to note that his method approximates very closely indeed to present-day practice. All small trees except teak were cut down and burnt on the spot, half the others girdled, and the rest left as shade and protection until the plantation was established. No soil preparation was undertaken except digging small pits for the seedlings. Plants were raised in nursery beds and the seeds were carefully selected, only the largest and best being used (The fact that teak seeds were peculiarly liable to attack by insects had previously been noted and this was most likely the cause of the failure of previous sowings.) They were further soaked for 36 hours before sowing. It is believed that several of these early plantations still exist in the Ataran Forest Division and a few notes on their condition, provided that they still survive would be of value.

7. Among later developments predicted by these pioneering officers, apart from methods of making plantations and the uselessness of fire protection, were several other suggestions. Wallich foresaw kheddahs in which elephants could be caught for working of timber on Government behalf, and Capt. Latter suggested experiments as to the time of year at which teak trees should be girdled so as to give the best results. It may be noted that this last experiment is actually being carried out in 1922.

8. In conclusion I hope that I have not made use of any of Stebbing's material over again. If I have unwittingly quoted extracts already given by him an apology is due and hereby offered. It is believed, however, that no such repetition occurs.

R. UNWIN, I. F. S.

NOTES ON AN ENTOMOLOGICAL TOUR IN THE UNITED STATES OF AMERICA AND CANADA.—(*concluded*).

BY J. C. M. GARDNER, I. F. S.

FOREST ENTOMOLOGY IN CANADA.

As the result of an invitation from the Division of forest insects of the Dominion Entomological Branch I was able to visit some of the most important forest insect control projects in progress in Canada. I received most valuable help and information from Dr. J. M. Swaine at Ottawa, from Dr. F. C. Craighead in the Spruce Bud-worm areas and from Mr. Hopping in British Columbia.

The Entomological Branch.—The Entomological Branch is one of the nine branches of the Department of Agriculture. The Forest Branch is under the Department of the Interior.

The Branch has the following Divisions :—

(1) Forest insects.

(2) Field crop insects.

(3) Foreign pest suppression.

(4) Systematic entomology.

In addition there are small sections dealing with insecticides, natural control, and mosquito control. A Division for control of fruit pests will soon be made.

The Division of forest insects was formed in 1919 and its staff is as follows:—Dr. J. M. Swaine, Chief of the Division at administrative headquarters at Ottawa ; Mr. R. Hopping is in charge of investigations in British Columbia and Dr. F. C. Craighead is in charge of investigations in Eastern Canada. In addition there are two more entomologists at Ottawa and also a number of

student assistants. A number of systematic entomologists usually work with the Division in the summer months.

With regard to funds the Entomological Branch benefits from two sources, the Entomological Branch vote of about $30,000 a year for administration of the Ottawa offices and the Destructive Insects and Pests Act which allots a sum ($ 140,000 for 1922) out of which the expenses of work outside Ottawa are paid.

Most of the Ottawa officials are paid from a separate Civil Service vote.

The chief problem of the Forest Division at present is :—

(1) Spruce Bud-work control.

(2) Bark-beetle control.

(3) Forest Sample Plot Studies.

Forestry in Canada.—The Canadian forests are vested in the provincial and in the Dominion Governments, the former owning by far the most; in addition a small amount of freehold forest land is held in fee simple by old-established lumber companies. The forest areas administered by the Dominion Government consist of Forest Reserves and Parks and the Dominion Railway Belt. The Forest Reserves consist for the most part of higher areas in prairie land which are not suitable for wheat growing The Dominion belt is a strip running twenty miles on each sides of the Canadian Pacific Railway and containing much valuable forest land. The National Parks are managed for aesthetic purposes by a Special Parks Branch.

The work of the Dominion Forest Branch consists for the most part in fire-control. With a view to improving the Reserves, a certain amount of timber is sold subject to controlled felling: with the same object a number of nurseries have been instituted and some planting is done. In addition the Service has a number of men occupied in Forest Research, as at the Pettawawa Station where a large number of sample plots are maintained for silvicultural research. Similar sample plots are maintained in co-operation with the Branch of Forest Insects, and also an area in co-operation with lumber companies.

Until 1921 a Commission of Conservation existed which aimed at making complete surveys of Canadian forests and elevating the standard of Canadian forestry generally. Their work had got as far as an exhaustive survey of the forests of British Columbia and the institution of numerous experimental areas when the Commission was dissolved; the experimental areas were taken over by the Forest Service.

The Provinces, which as mentioned before, own most of the forests, derive a considerable income by leasing cutting rights to lumber companies and also by stumpage charges. The provincial Forest Service supervises the cutting and places a diameter limit for example 12″ for Pine and 10″ or 12″ for Spruce: this seems to be an injurious system as the remaining smaller timber becomes liable to wind throw with consequent multiplication of bark-beetles, increase of fire-risk and danger to reproduction. Large areas of pure stands have been destroyed in this way in Canada.

The companies relinquish their leases at any time, but of recent years many of the larger companies have retained their land for future development and now tend to maintain the forests conservatively under the advice of trained foresters. The work of these foresters has largely been confined to mapping, estimation and nursery work with no control over cutting operations which are in charge of a woods manager, usually an experienced lumbering expert with little or no silvicultural knowledge.

One of the largest companies in Canada, Messrs. Price Bros., controlling 10,000 sq. miles of forest in Quebec, have given their forest expert complete control over all silvicultural operations.

With the object of awakening popular interest in forestry, particularly in avoidance of fire, the Canadian Forestry Association maintain a railway coach fully equipped as a museum, which continually moves about the country. In connection with this coach is a moving picture apparatus showing appropriate films.

A modern development may be mentioned here in the use of the aeroplane for reconnoitring purposes in forests. Messrs. Price Bros. of Quebec maintain a regular fire-spotting aeroplane service

which has proved very valuable. Considerable use of the aeroplane for enumeration purposes, etc., when suitable cruisers are obtainable. It may also be noted that the aeroplane was used successfully in Ohio for dust spraying a *Catalpa* plantation infested with destructive caterpillars. This of course is an expensive method but it may prove useful in the future.

Bark-Beetle epidemics in Canada.—My first stop of any length of time in Canada was at Vernon B. C. in May, where I met the Dominion Entomologist for British Columbia Mr. Ralph, whom I had the pleasure of accompanying on a 400 mile motor tour in the yellow pine forests.

The chief species in the areas visited were yellow pine (*P. ponderosa*) with a certain amount of Douglas fir and Lodgepole pine (*P. contorta*), the last frequently present pure stands on burnt over sites where it owes its prominence to the peculiar fire-resistant properties of the cones.

The yellow pine was suffering from an epidemic attack of the western pine beetle (*Dendroctonus brevicomis*) apparently more severe than in the Klamath (Oregon) region. Killed and dying trees here stood in groups of ten to a hundred and from these groups the infestation spread outwards year by year until whole hillsides were often devoid of living pine. One extensive slope noticed had just been treated, with the result that a former good stand of yellow pine and Douglas fir was represented solely by the latter.

The epidemics were in many cases traceable to near-by logging operations, which had provided large quantities of non-resistant breeding material. In connection with this we saw a very large accumulation of stacked logs, cut while infested the previous autumn, and now immovable owing to transport difficulties. These logs full of *Dendroctonus* larvæ approaching maturity, were causing considerable anxiety to the authorities who had recently treated neighbouring areas of forest at great expense and feared re-infestation.

There were five widely separate control centres in various parts of British Columbia. The method of control consisted, as

in Oregon, of felling infested trees and burning the bark. The work here was very laborious owing to the large number of trees to be treated, the precautions required to prevent fire spreading, and the steep hills which tended to roll the logs to be burnt into contact with standing trees, and injure them.

One point very noticeable in these forests is the abundance of mistletoes of the genus *Arceuthobium* which attack 15 per cent. to 30 per cent. of the trees and cause serious loss of height growth owing to localisation of food material at the seat of infection.

The Spruce Bud-worm in Canada.—After spending a fortnight in Ottawa working on *Scolytidæ* with Dr. Swaine, I accompanied Dr. F. C. Craighead to the spruce bud-worm areas in New Brunswick and Quebec. The great forests in Quebec, New Brunswick and Maine were stocked with white pine *(P. Strobus)* with a certain amount of spruce, until about eighty years ago, when the spruce began to replace the pine as a result of the lumbering methods used which consisted in removing the pine stems in order of quality with no regard to regeneration. The forests are now stocked with spruce (*Red, †Black and ‡White) and fir *(Abies sp.)* with the latter spreading rapidly owing to its superiority in regenerative powers over spruce in those regions.

These forests are of immense importance to the paper industry, and losses due to the spruce bud-worm attacks have led to extensive research with the main object of preventing similar outbreaks in the future, which judging from past history occur at intervals of about 40 years.

The newly hatched larvæ of the bud-worm feed at first on young growth of spruce and fir, and after consuming this, migrate to find new supplies of young growth. If the attack has been a severe one there will be insufficient young growth left and the larvæ will be forced to feed on the older fir foliage: they are unable to feed on older spruce foliage. The result is that the fir is more severely damaged and may be killed after 2 or 3 successive attacks.

* *P. rubra.* † *P. nigra* ‡ *P.* alba.

This weakening of vitality in both spruce and fir favours attack by secondary insects and fungi which give the final death-blow. Dr. Craighead estimates that 50 per cent. of merchantable fir has been killed and 3 years' increment lost on the spruce as a result of the epidemic which has been active for the last ten years.

Investigations show that control will depend on management mentioned by Dr. Craighead in the field in the future. Some points are summarised below :—

(1) Management with a view to elimination of fir and favouring of spruce reproduction.

(2 Mixture with hardwoods since the conifers are safe when under hardwood canopy. Early removal of conifers when hardwood canopy is passed.

(3) Short rotation for fir, since younger stands are less affected by the outbreak.

(4) Avoidance of large homogeneous stands.

(5) Utilisation of species suited to local conditions.

At present economic considerations preclude the companies from methods other than clearing the best timber.

As hardwoods have an important protective influence, a market must be found for them before they can be favoured.

J. C. M GARDNER, I. F. S.

DISTIRBUTION OF AGE AND DIAMETER CLASSES IN A NORMAL SELECTION FOREST.

In the French 1883 method, the ratio in volume between young, middle aged, and old crops is given as 1 : 3 : 5, it is a point of considerable interest to Indian Foresters to see whether this ratio is equally applicable to species growing under the very different growth conditions that exist in India. The preparation of a Yield Table for U. P. sal enables us to calculate the normal

distribution of diameter classes in a sal forest, and the calculation is given below for II Quality sal.

Diameter class. No.	Diameter class. Diameter, inches.	Diameter class. Mean Diameter, inches.	Maximum age of class, years.	Period taken to pass thro. class, years.	No. of trees per acre of even-aged forest of class.	Proportionate area covered by class.	No. of trees per acre of selection forest.	Volume per tree (total wood) 9 c.ft.	Total volume per acre of forest c.ft.	Per cent of Volume.
1	2	3	4	5	6	7	8	9	10	11
1	0—2 2—4	1 3	18	18	...	18/80	...	...	...	...
2	4—6 6—8	5 7	27 35	9 8	600 385	9/80 8/80	67 38 } 105	2·7 6·6	180 250	7 9 } 16
3	8—10 10—12	9 11	43 52	8 9	254 180	8/80 9/80	26 20 } 46	12·4 20	320 400	12 14 } 26
4	12—14 14—16	13 15	61 70	9 9	133 102	9/80 9/80	15 12 } 27	31 44	460 530	17 19 } 36
5	16—18	17	80	10	85	10/80	10	61	610	22
...	...	...	...	80	...	80/80	188	...	2,750	100

Explanatory notes.—Col. 4. Ages taken from Sal Yield Table, for even-aged crops. This possibly introduces a slight error since in a selection forest, growth is slightly slower at first, slightly faster later, but there are no other data available, and the error introduced is not serious.

Col. 5. From Col. 4.

Col. 6. From Yield Table for even-aged crops.

Col. 7. The area covered by each diameter class is assumed to be proportionate to the period of years spent in that diameter class. This is obviously true for the normal even-aged forest, and is therefore a *true* assumption for the normal selection forest.

For if we consider a forest composed of small even-aged groups (*e.g.*, the Corsican method for their pine forests), the above principle holds true, and we can reduce the size of the groups down to single **trees** (*i.e.*, the pure selection forest), without affecting the principle involved.

Col. 8. = Col. 6 × Col. 7.

Col. 9. From the sal volume table for single trees. Here again, data for even-aged crops are taken for a selection forest without introducing any serious error.

Col. 10. = Col. 8 × Col. 9.

An examination of the volume curve illustrates an interesting point.

If we divide it into 3 equal parts (*vide* dotted perpendiculars from points 6, 12, and 18), at points A, B, C, then the proportionate volumes of the 3 diameter classes

$$\left.\begin{array}{r} 0''-6'' \\ 6''-12'' \\ 12''-18'' \end{array}\right\} \text{ are represented by the areas } \left\{\begin{array}{l} \text{A. } 0{\cdot}6. \\ \text{B. A. } 6{\cdot}12. \\ \text{C. B. } 12{\cdot}18. \end{array}\right.$$

These areas are — Ratio off.

$$\begin{array}{lll} (1)\ 0''-6'' = \tfrac{1}{2}(215\times 6) & = 215\times 3 & = 1 \\ 6''-12'' = 215\times 6+\tfrac{1}{2}\,(\overline{430-215}\times 6) & = 215\times 9 & = 3 \\ 12''-18'' = 430\times 6+\tfrac{1}{2}\,(\overline{645-430}\times 6) & = 215\times 15 & = 5 \end{array}$$

Thus we have the standard ratio of the 1883 method. It is therefore proved that this ratio of 1 : 3 : 5 : applies equally to sal forests as to European forests. (This follows of necessity, if the curve of volume per acre is a straight line starting from zero.) But what is of greater practical importance in forest management is the curve of number of trees per acre. In one working circle of the sal forests of N. Kheri Division, which in the revised working plan is being managed on the true selection system, each compartment has been enumerated, and curves have been made for each compartment showing the actual growing stock as compared to the curve of normal growing stock. Thus the marking officer before he starts his markings can see at a glance which diameter classes are deficient and require encouraging, and which diameter classes are in excess, and

CURVES SHOWING No. OF TREES AND VOLUME OF WOOD PER ACRE OF NORMAL SELECTION FOREST
II QUALITY SAL.

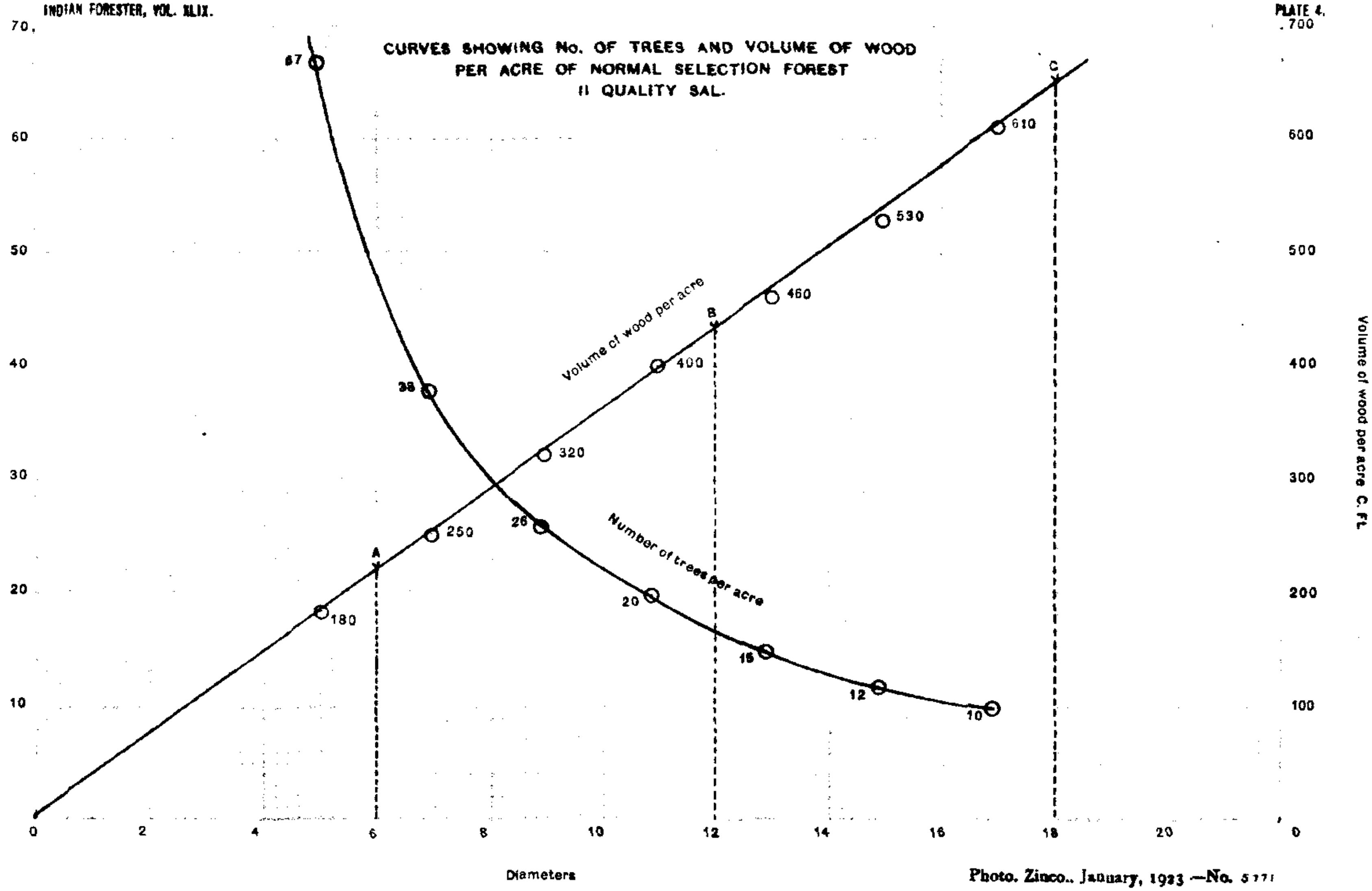


Photo. Zinco., January, 1923 —No. 5771

require felling. Without these indicating curves, it is easy to appreciate the feeling of hesitation and doubt in the mind of the marking officer, when he is let loose in an area with instructions to mark it, so as to tend to bring it to the state of a normal forest. Thus these indicating curves are essential to a system of true selection, and in fact, without the standard curve showing the number of trees of each diameter class per acre, with which to form a comparison between the actual and the normal forest, the selection system in this country (and, with the marking staff that is available) would be extremely difficult to work.

E. A. SMYTHIES,
Silviculturist, U.P.

*SUPPLEMENTARY RESEARCH REPORT OF ASSAM.

I. THE EVERGREEN FORESTS OF THE EASTERN CIRCLE.

1. Mr. H. L. Cooper's report on the enumeration survey carried out by him last cold weather in the Sadiya Forest Division has been received, and the results corroborate the description of the evergreen forests of this Circle given in paragraph 1 (i) of Chapter II of the Research Report, in fact, that description appears to have been too optimistic.

2. The results of Mr. Cooper's survey may be summarised as follows :—

(*a*) The forests were divided into four classes, *viz.* :—

(*i*) Class I, capable of producing per acre 2,400 cubic feet of timber of the more valuable hardwoods.

(*ii*) Class II, of producing 1,200 c.ft. per acre.
(*iii*) Class III, „ „ 550 „ „ „
(*iv*) Class IV, „ less than 550 „ „ „

* This Supplementary Research Report of Assam was originally meant for incorporation in the Progress Report of Forest Research Work in India, 1921-22, but being received too late, is now published in the "Indian Forester," as being of general interest.—HON. ED.

(*b*) Of the 752 square miles of forests surveyed there are estimated to be—

7	square miles	of I	class	forests,	or 1 %	of the area	surveyed.
15	,,	,, II	,,	,,	or 2 %	,, ,,	,,
89	,,	,, III	,,	,,	or 12 %	,, ,,	,,
641	,,	,, IV	,,	,,	or 85 %	,, ,,	,,

(*c*) It is very doubtful whether the exploitation of forests of Class III will be a paying proposition except where they are accessible to roads or tramlines, and the exploitation of forests of Class IV will certainly never pay.

(*d*) Even estimating that a quarter of the Class III forests will be exploitable, which is probably too optimistic, the total exploitable area will only be about 44 square miles and even a considerable proportion of this will be difficult to work as some portions of the I and II Class forests are very inaccessible.

3. In the Sibsagar Division, Mr. Mackarness has carried out a survey of the Lower Doygurung Reserve, which was thought to be fairly well stocked with the more valuable hardwood species, but the results show that the average number of trees of such species per acre over the whole Reserve (*i.e.*, 5,120 acres) is only ·7!

4. The results of these enumeration surveys are very disappointing, and it is feared that the other surveys which are now being carried out in the Lakhimpur and Sibsagar Divisions, will show equally poor results.

II. PLANTATIONS.

1. It is obvious that in forests of this description the only possible method of regeneration is by means of artificial plantations, in the formation of which, the best policy to adopt (to quote from Burma Forest Administration Report, 1920-21) "is to choose the most valuable species suited to the locality to be regenerated; to confine the regeneration in the different types of forests to a number of species of proved commercial value; and, provided the

locality is fairly constant and suitable for the species to be planted to regenerate not less than 20 acres in one block with one species in order, in the future, to allow for economical exploitation of each species."

2. From the results already obtained in experimental plantation, it is estimated that a plantation of the more valuable hardwood species should not cost more than Rs. 43 per acre. This includes cost of formation, and cost of tending up to the age of 55, at which age it is believed the trees will reach an exploitable size and the plantation should be capable of producing 4,000 cubic feet of timber per acre.

This timber, being well grown and very accessible, should be worth at least 6 annas per c.ft. in the log, and the profit should not be less than Rs. 59 per acre, calculating the present value, at 5 per cent. at about Rs. 102.

3. Divisional Forest Officers are now preparing plantation schemes, which will prescribe exactly the areas to be planted up during the next five years and the arrangements which will be made as regards the recruitment of labour. The latter is very important, as labour is difficult to get during the rains when plantations need most attention, but it is hoped to get over this difficulty by recruiting, on an attractive scale of pay, a more or less permanent staff of labourers.

III. SUPPLY OF FIREWOOD.

The shortage of firewood in some Districts, notably in Darrang, is becoming a serious question, and therefore the report recently submitted by Mr. Jacob, Divisional Forest Officer, Darrang, on the *bokain* plantations on the Monabari and Orang Tea Estates, Darrang, is of interest (a copy of the report is published in the following pages). Copies of the report are being circulated to all Divisional Forest Officers who will bring them to the notice of the Superintendents of Tea Estates in their Divisions, in the hope that similar plantations will be formed in other parts of the Assam Valley where firewood is becoming scarce.

IV. Supply of simul (Bombax malabaricum).

As regards the supply of *simul* (*Bombax malabaricum*) for the manufacture of tea "shooks" (not veneer boxes), Mr. Cooper, Divisional Forest Officer, Sadiya, reports that, provided the Political Officer continues to enforce the rules prohibiting the felling of *simul* in *jhums*, there should be a sufficient stock of this species to supply the local demand indefinitely. It is still uncertain how far the new veneer box, which in the Sadiya Division is manufactured mostly from *hollock* (*Terminalia myriocarpa*), will supersede the old *simul* "shook". As far as can be seen at present, there will always be a certain demand for *simul* "shooks" but considerably less than it is at present.

V. Sawmills.

The number of sawmills in the Eastern Circle manufacturing over 15,000 tea shooks annually is twelve, *viz.* :—

Division.	Name of mill.	Owner.	Approximate capacity.
Sadiya ..	Laimakuri ...	Assam Saw Mills and Timber Co.	3,00,000 cubic feet per annum.
Lakhimpur ..	Hopewell ...	Do. do ...	50,000 tea shooks ,, ,,
,, ...	Baduty ...	Do. do ...	80,000 ,, ,, ,, ,,
,, ...	Bordeobam ...	Jokai Tea Co. ...	16,000 ,, ,, ,, ,,
,, ...	Ghoorenia ...	Babu Rampat Das	30,000 ,, ,, ,, ,,
,, ...	Halcutta ...	Babu Joy Narayan Dhelia.	50,000 ,, ,, ,, ,,
,, ...	Margherita ...	Assam Railways and Trading Co.	1,80,000 cubic feet ,, ,,
Sibsagar ...	Naginijan ...	Naginijan Tea Estate	48,000 ,, ,, ,, ,,
,, ...	Jamaguri ...	Furkating Saw Mills Co.	1,20,000 ,, ,, ,, ,,
,, ...	Desang ...	Sjt. J. P. Chaliha	24,000 ,, ,, ,, ,,
,, ...	Jansi ...	Jansi Tea Estate.	
Darrang ...	Tezpur ...	Assam Saw Mills and Timber Co.	1,00,000 tea shooks ,, ,,

The large sawmill at Sissi, Lakhimpur Division, which belonged to the Assam Saw Mills and Timber Co., was completely destroyed by fire in November 1921.

In addition to the twelve mills mentioned above a large veneer and three ply factory has been erected this year by the Assam Saw Mills and Timber Co. at Murkong Sellek in the Sadiya Division capable of turning out 1,500 boxes per diem, and a similar factory is now in course of construction by the Assam Railways and Trading Co. at Margherita in the Lakhimpur Division. The latter firm is also erecting a sleeper-treating plant at Margherita, for there is no doubt that within the next few years, treated *hollong* and *hollock* sleepers will largely replace the use of *nahor* and sal sleepers on the Dibru-Sadiya and Assam-Bengal Railways.

F. H. TODD, I. F. S.

NOTE ON *BOKAIN (MELIA AZEDARACH)* PLANTATIONS ON MONABARI TEA ESTATE.

1. *Situation and soil.*—The situation of the plantation is about 2 miles from the Brahmaputra river near Katonibari steamer ghat. The land is flat, covered with grass about 5 ft. high at time of inspection, and fairly well drained; there is a light surface soil about one foot deep, broken up with the grass roots, and beneath the soil is pure sand, the old bed of the river. The tea garden is almost entirely without fuel; indeed, when I was in charge of this Division in 1913—15, the previous Manager told me that it was difficult to obtain natural manure for the tea, as the coolies collected all the cattle droppings which they could find and dried them for fuel, owing to the lack of wood. Since that time an area has been leased for fuel, some 7 miles away but this is a long distance to cart fuel, and the cost is considerable.

2. *Area and age.*—The plantation was commenced in 1918 and extended in 1919 and 1920; the exact area has not been surveyed, but roughly 15 acres were planted in 1918, 8 in 1919, and 5 in 1920. The 1918 plantation was entirely successful but

of the 1919 and 1920 plantations 5 acres and 2 acres respectively were failures.

3. *Method of planting.*—The plants were removed from a nursery in baskets, when about 9″ high, and planted at stake in February and March, 10′ × 10′. Patches, about 2′ square at each stake, were previously hoed up to the depth of one foot. The planting was done about the same time each year. The grass was not cleared, except at the stakes, and no subsequent cleaning or weeding was done.

Troup lays emphasis on the necessity for weeding (*vide* "Silviculture of Indian Trees," volume 1, page 180) but from the results obtained it does not appear necessary on a soil of this type.

4. *Present condition of crop.*—The results are very good. The trees of 1918 planting average about 30′ high, with a girth at 4′ of 20″; 1919 average 22′; and 1920, 15′. A few trees of 4 years old have been cut in thinning, but otherwise nothing has been removed. It would be advisable next year to thin the whole of the oldest plantation; probably about one-third could with advantage be removed, and the fuel yield would be considerable.

A few vacancies in the 1918 planting, were filled up in 1920 with young plants; this is of little use, as the shade of the other trees, light as it is, seems sufficient to check the growth; these plants are still alive, but have scarcely grown at all. In any case the branches form a canopy so quickly that it does not seem worth while filling up vacancies, provided the main crop has been more or less successful.

5. *Cost.*—Unfortunately no record has been kept of the cost; I asked the Manager if he could give me some idea, but he said he was unable to give any estimate, except that the cost had been very small; the planting was done at the time of year when work is fairly slack on a tea garden; pruning is nearly completed, plucking has not commenced, and it is necessary to employ the labour, which has to be paid in any case; indeed this was largely the reason for making the plantation. As no weeding has been done, the cost cannot have been high.

The following is an estimate of the cost per acre based on figures obtained from the Orang plantation :—

		Rs.	a.	p.
A. $\frac{1}{4}$ maund seed at Rs. 3 per maund	...	0	12	0
B. Cost of nursery for 1 acre ...	..	5	0	0
C. Original clearing of patches ...	...	5	0	0
D. Planting out, one coolie can carry and plant 40 plants at 6 annas, say 440 per acre	...	4	2	0
		14	14	0
or say	...	15	0	0

NOTE.—A.—The amount of seed required was probably less than this, as, not only was the spacing 4 times as far apart as that of Orang but 3 to 4 seeds were sown at each stake in the latter case.

B.—It is very difficult to say what this cost would be, but I consulted the Manager of Orang and we agreed that Rs. 5 was a fair estimate.

C.—The cost of preparing the patches at each stake is estimated at $\frac{1}{2}$ the cost of an original deep hoe.

6. *General.*—If the plantation is extended by, say 10 acres per year, the Company will have, after a few years, a very valueable asset. *Bokain* certainly is very successful on this soil, and very little weeding appears to be necessary. At any rate, I cannot imagine that the results could have been much better had weeding been done. The only danger that I can see is the possibility of fire: on the west side, the plantation is safe, as it borders on the tea, but it would be advisable to clear fire lines on the other sides.

(Sd.) W. R. LEG. JACOB,
Deputy Conservator of Forests,
Darrang Division.

NOTE ON *BOKAIN (MELIA AZEDARACH)* PLANTATIONS ON ORANG TEA ESTATE.

1. *Situation and soil.*—The plantation is situated on Orang Tea Estate 36 miles from Tezpur, and 5 miles from Orang Inspection Bungalow on the main road from Tezpur to Mangaldai.

The soil is sandy, but slightly heavier than that of Monabari, and is a light sandy loam. As in the case of Monabari, the garden is without any fuel supply, on or adjoining the Company's land. The area was covered with grass, without tree growth of any kind. The land is fairly high, and naturally well-drained.

2. *Area and age.*—The plantation was formed in 1920, and 1921; about 8 acres were sown in the former year, and 4 acres in the latter.

3. *Method of formation.*—The plantation was formed by direct sowing; the area was deep-hoed, and seed was sown at stakes 5′ × 5′ in July of each year, 3 to 4 seeds being sown at each stake. I could not get information, whether the seeds were covered with soil, and at what depth, as the present Manager was not then in charge of the garden. Subsequently 3 light hoeings were done over the whole area until the plants were sufficiently high to look after themselves.

The treatment was the same in both years. Incidentally the seed was purchased from Monabari.

4. *Present condition of crop*, 1920 *sowings.*—The average height is 20′, varying from 14′ to 30′, with a girth of from 10″ to 24″, averaging about 14″. The growth is on the whole very even. The sowings were undoubtedly made much too close, and this is clearly shown in the outer row, where, with about the same height growth as the remainder, the average girth is about double that of the rest of the plantation.

1921 *sowings.*—Average height 15′, and up to 20′, with a girth of 6″ to 14″. A small portion, about ½ acre, averages only about 8′ and this is on slightly lower land, where the drainage is less good. The former remarks about the outer row apply also here,

5. *Cost.*—Although no detailed record of the cost was kept, the Head Clerk kindly made an estimate, which the Manager considers fairly correct.

Cost per acre.—

		Rs.	a.	p.
½ maund seed at Rs. 3 per maund	...	1	8	0
Original deep hoe	...	10	0	0
3 rounds light hoeing at Rs. 3-12-0 a time	...	11	4	0
Staking and sowing, one coolie can do 200 at 6 as. at 1,200 to the acre ...	...	2	4	0
Cost per acre	...	25	0	0

NOTE.—1,200 would be 6′ × 6′. This is the estimated number of stakes given by the clerk; but I measured the spaces in very many cases, and they were certainly less than 6′ in every case.

General remarks and comparison with Monabari plantation.—The growth at Orang is undoubtedly better than at Monabari; there is little difference in the soil, and the trees have responded to the extra cultivation. But the spacing is far too close in the former plantation, and it would have been better to have sown 10′ × 10′. The question is whether the extra cost will be compensated by the more rapid growth.

The one year old on Orang are as large as the two years old at Monabari; but I inspected the former nearly two months after the latter, and this period, at the best growing time of the year, must be considered in a tree showing so rapid a growth. I think it probable, that with direct sowing a considerable amount of cultivation is absolutely necessary, so that to a tea company the question of sowing and planting depends largely on the labour available; if sufficient labour can be spared, sowing appears preferable, but otherwise planting should be done.

7. *Estimate of rotation and yield.*—I estimate 8 years as the rotation for planted areas, and 7 years for sown areas, which have been well cultivated at the commencement.

From what I have seen of isolated trees, *bokain* does not coppice well from large stumps, but I have seen excellent coppice from stumps of about 3′ girth.

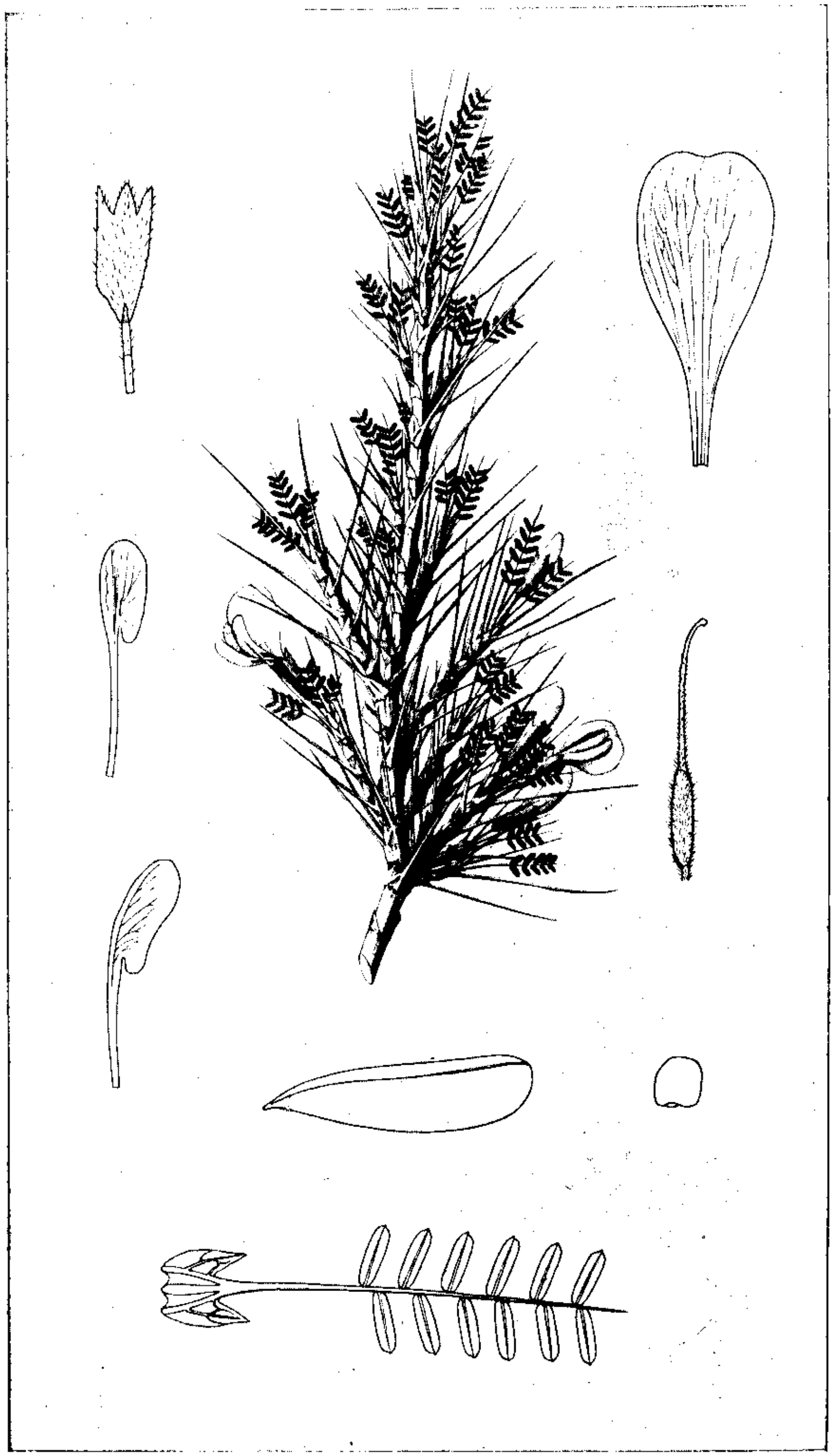
The anticipated yield is :—

200 trees per acre at 7 or 8 years rotation at 25 cubic feet stacked per tree ...	5,000 c.ft. stacked.
Yield from thinnings say 150 trees at 6 c. ft. stacked	900 do.
Total yield stacked, cubic feet ...	5,900

(SD.) W. R LEG. JACOB,
Deputy Conservator of Forests,
Darrang Division.

A NEW SPECIES OF *ASTRAGALUS* FROM KUMAON.

Astragalus aegacanthoides. Parker species nova.—Frutex humilis 60-90 cm. altus, ramuli juniores hirsuti mox glabrescentes pubes alba basi fixa. Folia 3-4 cm. longa, paripinnata, petiolo spinoso. Stipulae petiolo adnate, membranaceae, amplexicaulae, ad 8 mm. longae, apice acuminatae. Foliola 4-6 juga, elliptico-oblonga vel oblonga, 6 mm. longa, 2 mm. lata, supra glabra, subtus et ad margines leviter hirsuta, juniora utrique hirsuta, nervis lateralibus obscuris. Flores flavi, axillares, solitarii ; pedunculi 3 mm. longi, bractae minutissimae vix conspicuae ; pedicelli, pedunculis aequales vel paulo breviores ; bracteolae 2, lineariae, hirsutae, circa 1 mm. longae, basi calycis insertae. Calyx 10 mm. longus, tubulosus, hirsutus, basi leviter gibbus, dentes subaequales, lanceolati, quam tubo dimidio breviores. Petala filamentorum xaginae libera ; vexillum obovato-oblongum, leviter retusum, sensim in unguem attenuatum, 23 mm. longum, 10 mm. latum ; alae carinum vix superantes, laminis oblongis basi breviter auriculatis infra medium leviter saccatis ; carina 18 mm. longa obtusa. Stamen vexillare liberum, caetera in vaginam connata. Ovarium dense hirsutum, stipite 1·5 mm. longo suffultum, circa 9 ovulatum ; stylus infra hirsutus apice glaber ; stigma minute capitatum, nudum. Legumen illis generis *Caraganae* similis. 20 mm. longum, 6 mm. diametro, cylindricum, acutum, sutura saltem ventrali tumida,



Astragalus aegacanthoides, Parker.

extra fere glabrum, intra substantia inter membranaceam villosamque farctum, omnino indivisum. Semina 3 mm. longa subquadrata.

Kumaon 3,300-4,200 m. Vallis fluminis Kali ad Byans *Lyall* 36. Vallis Nipchang *Duthie* 2,806.

Duthies' specimen collected on 31-10-1884 is in fruit, Lyall's collected on 27-5-1913 is in flower. The latter quotes the Bhotia name *nátha.*

As the genera *Astragalus* and *Caragana* are at present defined this plant appears to belong to the former rather than to the latter Treated as an *Astragalus* it would fall into Bunge's section *Aegacantha* (Bunge, Generis *Astragali*, Species *Gerontogeae* in Mem. Acad. Sc. Petersb. ser VII xi, No. 16). This section is a very uniform one except for one species (*A. ovigerus*, Boiss.) which differs from all the rest in its pod. Boissier (Fl. Orient II, p. 316) has however removed *A. ovigerus* to another section of the genus thus leaving *Aegacantha* a very natural and homogeneous group Our species differs from all the members of the section *Aegacantha* most markedly in its pod, and to a lesser extent in the equal divisions between the calyx-teeth, the slightly saccate wings and in not having a reniform seed. In all these respects it resembles a *Caragana*, but in a genus the size of *Astragalus* there is naturally a good deal of variation especially in the pod, which in several species is like that of a *Caragana* rather than the more usual *Astragalus* type. To include this new species in the section *Aegacantha* would spoil the uniformity of the section, and I should prefer to place it in a separate one of its own, or even to transfer it to *Caragana* as I do not think it is at all closely related to any *Astragalus* of the *Aegacantha* section although superficially it closely resembles them.

The illustration shows a flowering branch and enlarged figures of the calyx, standard, wing, keel, ovary, pod and seed.

R. N. PARKER, I. F. S.

THE BIGGEST TEAK LOG EVER BROUGHT OUT FROM THE FORESTS OF BURMA.

Mr. J. E. B. Summers has kindly given me the following history of what I believe is the largest teak * log ever extracted.

He was at the time an assistant to Messrs. Darwood and Co., who were working the forest of the Shweli Valley which lies in the Momeik State and the Ruby Mines district, some distance north of Mandalay. This valley has long been noted for its teak forests, and it is said that the magnificent pillars of the palace at Mandalay are all single teak logs from these forests. The tree was felled by a Kadaw villager Maung Aung Zan in 1898 or 1899, and was dragged out as one log by five elephants, two of which were "Pateboh" and "Patemah." It was growing on the right bank of the Tonkyauk stream, a tributary of the Maingtha which flows into the Shweli river. When put into the stream there were some 400-600 logs above, and the big log was tied up to the bank in order to let the others pass, and was then cut adrift and floated out the following year on a big rise.

Mr. Summers thinks the log was measured at Inywa, at the mouth of the Shweli river, by Mr. A. B. Powell of the Forest Department and Mr. Petley of Darwood and Co.

The photo was taken by Mr. G. V. Clark, who was then in charge of Kunchaung, Darwood's lower agency in the Shweli. The log is 82½ feet long and 10 feet in mid girth, and contains 391 cubic feet of timber. It is still lying at Rangoon. Messrs. Darwood and Co. had some idea of sending it to an exhibition, but no ship could or would take it.

A. RODGER, I. F. S.

* An article on "Big Teak in Madras" appeared in the "Indian Forester" for May 1920, page 247.

The biggest teak log ever brought out from the forests of Burma.

BETTER FORESTRY THROUGH BETTER UTILISATION.*

By AUTHUR T. UPSON, In Charge Section of Industrial Investigations, Forest Products Laboratory.

IN its most limited sense, forestry has been defined as the management of growing timber; in its broadest sense as the science, art, and business of producing, reproducing, and improving forests for forest purposes and of practising the most appropriate methods of harvesting, converting, and disposing profitably of forest produce.

* Read before the annual meeting of the Society of American Foresters, 27th December 1921, Toronto, Canada.

over that of 1920-21, and the average of the last 5 years. The falling off in revenue from other sources, was mainly due to the transfer from the "Forest" to the "Land Revenue" head, of the revenue from mica, iron ore and other mineral products. This resulted in the Hazaribagh Division, where the mica comes from, being worked at a loss.

A Provincial Silviculturist was appointed from December, 1921, but his work was confined to utilisation until March, when he proceeded on leave. Several consignments of leaves and root barks of *Vitex peduncularis* for treatment of malaria and black-water-fever were sent from Singhbhum to Bombay, Madras, Ranchi, Assam, Calcutta and England. The Divisional Forest Officer anticipates, that unless artificial reproduction of this plant be undertaken, it may not be possible to meet the steadily increasing demand from the present stock in the forests. The gathering of leaves is reported to do no great harm to the trees, but the compliance with demands for root bark is destructive. Propagation by cuttings proved only partially successful.

We congratulate the Conservator Mr. E. R. Stevens on a most interesting report, evidence of a generally sound and progressive policy which should yield good results in the near future.

F. K. M.

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How far forest utilisation is a part of forestry has been a much mooted question. It is becoming more and more recognized, however, that utilization plays an important part in the practice of forestry, but just where utilization of wood, in its course from the forest to the fabricated wooden article, ceases to bear a direct relation is still another question. The object of this paper is to point out that, regardless of where waste of raw material may occur, such waste, its elimination or its utilization, will still have a most vital effect on the business of forestry.

In this country, the product of the forest is subjected to greater losses than any other raw material. These losses first in the woods, then at the sawmill, and finally in the wood working factory aggregate more than 80 per cent. of the volume of the original forest. It is true that many losses are unavoidable, but it is equally true that many are needless wastes. Elimination of all loss in harvesting and using forest products is the ideal, but nevertheless one that cannot be attained under present conditions. Further research on wood utilization will contribute much in that direction, but meanwhile the waste problem must be attacked from another angle also.

This is, by more complete utilization of material now disposed of as waste, and includes both unavoidable as well as avoidable waste. Ways and means of making use of waste in the past have been largely through utilization of chemical means and accomplishments in this line have been remarkable. Results of recent research at the Forest Products Laboratory of the U. S. Forest Service show, that in merely using sodium carbonate in the process of destructive distillate, production of wood alcohol can be increased from 50 to 100 per cent.; that ethyl alcohol can be produced from the pulp held in solution by spent liquor in the sulphiate process of pulping wood, thus utilising a large portion of the 55 per cent. of original wood heretofore wasted; that used newsprint can be profitably deinked and remanufactured into paper; that all wood subjected to decay can be economically preserved by chemical treatment; and that many other savings in raw material can be made through chemical methods of treatment and use.

Moreover, research is pointing out ways for eliminating wood losses, through physical means. Through exhaustive tests on the mechanical properties of wood, allowable working stresses for heavy timbers can be increased by 20 per cent. effecting an annual saving of two or more billion feet of timber. Better kiln drying methods will permit complete utilization of another two billion feet, now lost each year through inefficient but entirely avoidable drying methods. And better methods of box and crate construction will conserve over one billion feet of lumber, as well as millions of dollars worth of commodities lost annually in shipment.

Granted, however, that these reductions and elimination of losses, are resulting from present day research, there is still an enormous field almost untouched, but which, from early indications, promises to present still greater opportunities for conservation of raw material. Those in the industries, who are acquainted with the facts, state that the new work on wood waste problems just undertaken by the Forest Products Laboratory, is the greatest economic movement ever initiated in connection with the manufacture and use of forest products. Moreover, its scope is enormous, the field unlimited. The underlying principle of this new work, is standardization of products and requirements of all wood-using and consuming industries, and more effective wood utilization through mechanical means as distinguished from chemical and physical means.

In this new research two investigations stand out most prominently, although they hardly touch the field.

The first of these, is the standardisation of nomenclature, sizes, grades and specifications for lumber, cross ties, and other wooden products.

Lumber is to-day manufactured from more than thirty commercial species in general use, and each species is graded, inspected, and marketed under its own set of rules. These rules are in most instances, the outgrowth of early conditions when the use of lumber was not refined as it is to-day. The result is, that present lumber grades not only do not fully meet the requirements of

use but they are so complex and misleading that the average consumer has no assurance that he is getting the material best suited for his needs. Similarly, cross ties are now manufactured, marketed, and utilised under varying conditions as to size, grade, species, inspection, price in relation to quality of material, etc. In the tie industry as well, either the manufacturer or consumer suffers, as a rule, from lack of standardization.

The objects and advantages of standardization of both lumber and ties are manifold. The most important are, to simplify purchases, by making possible a common language for all; increase efficiency, ease and accuracy of inspection; render possible the substitution of one species for another, with the assurance of getting the species desired, and of the same size and grade; render statistical interpretation more intelligible, in comparing prices of competitive species, sizes, and grades; reduce selling costs, and unit costs to the public; stabilise production and employment; and eliminate indicision both in production and utilization—one of the most prolific causes of inefficiency and waste.

This second important research problem in the new programme will produce earlier and more far-reaching results in bringing about more complete utilization of wood. This project deals with the standardization of the small dimension stock requirements of all secondary wood-using industries. It involves the production and marketing of this material by the sawmill and its use by the consumer in the form of ready-cut rough stock in the required small sizes.

The secondary wood-using industries now consume annually over eight billion board feet of lumber. In present practice these industries purchase and use high grade lumber and planking, the products of the sawmill, and after shipment to the wood-using factory, remanufacture it into stock of small sizes, at great losses in raw material, transportation charges and operating expense. The waste in raw material alone incident to this form of converting wood, considering all grades, averages 50 per cent.; while if the waste incident to the conversion of the log into the original lumber and planking is considered in the final utilization, then only

about 17 to 20 per cent. of the total volume of the tree is obtained.

On the other hand, it is unnecessary to use high grade boards and plank for the production of the requirements of these industries. Although this stock must itself be clear and of high quality, it can, on account of the small sizes and shapes usually required, be produced from low grade raw material, lumber by-products, and much other material now disposed of as waste at the sawmill and in logging operations. Slabs, edgings, and long trimmings, will yield this material, and also much can be made from the lowest grades of lumber now produced, in comparatively high and increasing proportions in every mill operation and so often yarded only to rot or be given away for the cost of handling.

With dimension stock standards and markets, and by education of the producer and consumer, the sawmill can convert these by-products and low grade material directly into the form and quality of material required by the wood-using industries. This will lessen the industries demand for high grade lumber, and will afford a profitable outlet for material now unutilized. In turn the annual drain on our remaining timber supply will be relieved to the extent of four or five million board feet.

Detailed investigations by the Forests Products Laboratory in connection with this method of utilization of wood waste, have been under way for several months. Time, cost, and efficiency studies are being conducted in chair and wood-turning factories. Likewise, other industries such as the furniture, automobile, vehicle, etc., will be covered. Studies of similar scope, will be conducted in logging and milling operations.

Now, how will conditions existing in logging, milling, and manufacturing operations, be effected by this new method of converting the standing tree, into the products required by wood-using industries, and by standardization of the products and demand of the producer and consumer?

Sawmills are to-day usually located near the source of raw material, usually in the smaller communities. There, 25 per cent. of the original volume of the forest is left in the

woods. About 45 per cent. is wasted at the mill. Here the logs are manufactured into boards, plank, and structural timbers of random sizes, usually regardless of whether they meet the requirements of use. Operating expenses are comparatively low, because operations are carried on on land of low potential value, where living costs are low and where labour is economically employed.

Large quantities of boards and planking are then shipped to consuming factories, where the material is rehandled, usually seasoned both in the open and in kilns, and finally resawn into small rough stock of the various sizes required in the manufacture of innumerable wooden commodities. Seldom, if ever, is thought given to the widths or lengths of lumber most suitable for re-working into these articles. Defects and blemishes are scattered promiscuously throughout the pieces and in remanufacture the consumer must take chances on dodging them.

These manufacturing operations are carried on usually in the larger cities, where overhead costs are extremely high, factory sites are costly, and labour is not as economically procured as in the woods or sawmills. Then also, these consumers pay needless freight charges, on this material they are compelled to waste. It is true, that some of this material can be disposed of locally for fuel, but only at a figure insignificant, as compared with the original value.

In contrast, with these new methods of conversion, practised at the source of raw material, production costs for fabricated wooden articles will be lowered. Much of the 25 per cent. of the forest now wasted in the woods, and the 45 per cent. wasted at the mill, will be utilised for clear high grade marketable small dimension stock. The balance of unutilised waste, and the 15 per cent. or so, of the volume of the forest now wasted at consuming plants throughout the United States, will be concentrated at or near the mill and source of raw material. With this condition obtaining, chemical utilisation of waste can be more universally practised.

Finally, what will be the effect upon economic conditions and the practice of forestry? A part of the manufacturing

operations now conducted in the cities will be moved to the small forest communities, and this will make for permanent forest employment. Much of the urban population will be transferred with these operations, and this will stabilise forest communities. The more complete utilisation of the products of the forest will greatly increase stumpage values.

And, permanent forest employment, stabilised forest communities, and increased forest land and stumpage values, are the heart and essence of real forestry.—[*The Australian Forestry Journal, Vol. V, No. 9.*]

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RIGHTS AND PRIVILEGES IN BURMA.

It is implied in the Burma Forest Act that villagers by removing forest produce from waste land near their villages thereby acquire prescriptive rights to free grazing and a free supply of fuel and house building material in perpetuity. This assumption has necessitated an elaborate procedure for the settlement of reserves which causes great expense and delay, and will, I think, in future years give rise to endless difficulties.

It is the obvious duty of the State to conserve the forests on the main watersheds, not only to prevent erosion and to protect the water-supply, but also because the forests are of considerable value and the land practically useless for field crops. The land is the property of the State, and there should, therefore, be no difficulty in the Forest Department assuming control of these areas, but although the Department has been in existence for many years, the work is still unfinished.

It is the rights which cause complications. A special magistrate has to be notified, to inquire into and adjudicate the claims,

and the proceedings are then forwarded to Civil and Forest Officers of gradually ascending degree, each of whom records an opinion, learned or otherwise, until finally the proceedings are printed and submitted to the Local Government for sanction. The result is that it is usually three or four years before even the simplest reserve proposal is finally sanctioned.

At present the greater part of Burma consists of waste land covered with jungle which is of little or no value except to the people living in the locality, and it would, therefore, be a dog in the manger policy to prohibit villagers from helping themselves to such forest produce as they may require. But although the present generation may find it difficult to realise, it is quite certain that these conditions will not continue indefinitely. Some 500 years ago the greater part of Europe was, I believe, similarly covered with natural forest, but the last vestige of jungle disappeared many years ago. Developments in the United States, Canada and Australia have been even more rapid, and in many parts of India and China, forest produce has become so scarce that the people have been reduced to building houses of mud or to using cowdung for fuel, or other expedients. Already in Burma large areas of jungle in the Delta and along the river and railway lines have been cleared for purposes of cultivation, and as population increases and communications improve, conditions will gradually change. In all fully populated countries, the cost of forest produce is very high, and it is quite certain that in Burma with the gradual disappearance of the natural forest, the cost of forest produce will steadily rise. Any person, therefore, who has been awarded free grazing or a free supply of fuel and house building material, will have the equivalent of a handsome annuity which will continue from generation to generation, and these rights will ultimately attain a value of many thousands of pounds. The question arises who will pay for these rights, or rather who will suffer financially by the grant of these rights. The majority of tax-payers will, owing to changes in economic conditions, have gradually been deprived of free supplies of forest produce, and it is they who will be called upon to suffer financially on account of favoured individuals, whose ancestors happened to reside near

a tract of forest which was selected for reservation. This may be the law of the land, but it is not justice.

It is, however, very doubtful, I think, whether there is any real foundation for the assumption that prescriptive rights to forest produce can legally be acquired. A prescriptive right is, I believe, an absolutely permanent right which can only exceptionally, and with great difficulty, be modified, and never at the discretion of the State. For instance, a right of way is often an intolerable nuisance to the owner of an estate, and may seriously detract from the value of his property, but even if he is prepared to pay heavy compensation, it is, I believe, impossible to get such a right extinguished and seldom modified. I know no precedent, however, for prescriptive rights being acquired merely by the process of persons helping themselves to produce. For instance, it is a well established custom in most parts of England, for persons to roam over private lands in search of mushrooms, but although I have no doubt the custom has existed for centuries, this does not appear to debar the owner or tenant from ploughing up his pasture, which automatically prevents the growth of mushrooms and thus effectually puts a stop to the practice.

When a new country is developed, small colonies of settlers honeycomb the natural forest, which gradually disappears. These settlers naturally help themselves freely to the timber and fuel near their homesteads, and if they thereby acquired prescriptive rights to a free supply of timber and firewood, would not lightly surrender their claims. In Canada and the United States, for instance, the settlers are quite shrewd enough to realise the value of such rights, and if legally entitled to do so, would insist on a belt of forest being left near each settlement for the satisfaction of their claims. So far as I am aware, however, such claims have never been admitted in any country except India, and moreover in India, it is only when the Forest Department wishes to acquire land under the process of reservation, that such rights are ever admitted. The inhabitants of a certain village may have for centuries obtained their supplies from an adjacent forest, but the Land Revenue Manual authorises the destruction of this forest, provided the land

is taken up for permanent cultivation, and that land revenue is paid, and no provision is made for settling claims.

Moreover, even the Forest Act is not consistent on this point, as, although in the sections relating to reservation it assumes that prescriptive rights can be acquired, it authorises the Local Government to declare any tree to be a reserved tree, notwithstanding the fact, that villagers may for years have been accustomed to depend on that particular tree for their houseposts.

A Resolution passed by a Conference of Commissioners and Conservators in October 1919, was as follows :—

" That apart from the legal question the Conference is of opinion that the rural community should enjoy the use of forest produce for domestic and agricultural requirements, subject to such restrictions as are necessary in the interests of conservation. The user should be free, or subject to the payment of charges according to local conditions. With a view to preventing avoidable discontent, any restrictions which are imposed, should be imposed very gradually, and with great discretion. Further the Conference is of opinion, that it is undesirable to emphasise the legal aspect of the question."

Shortly after the annexation of Lower Burma, a notification was published in the Gazette declaring all produce on waste land to be the absolute property of the Local Government, and supposing therefore, the Government revived this declaration, and openly asserted its power legally to impose whatever restrictions it pleased, but at the same time qualified the declaration by asserting its intention of respecting the customs, and practices of local communities, so far as might be compatible with its obligations to the whole community, what would be the effect ? It is obvious, I think, that there could be no drastic or immediate change of policy. One cannot eat one's cake and keep it, and conservation is impossible, unless the public can be excluded. Experience in the unclassed forests has proved that, when the rural community enjoys the use of forest produce, it rapidly denudes a forest of all valuable timber. To deprive villagers of these privileges in forests from which they have been accustomed to obtain their requirements, or to impose such measures of

restriction as would restore the productive capacity of these forests would inevitably cause great discontent which Commissioners and Conservators unanimously agree should be avoided. It follows, therefore, that as heretofore, reservation must be restricted to the highlands which are practically uninhabited owing to the population gravitating down to the rich fertile plains, and untouched owing to their inaccessibility.

But even if there would be no drastic change of policy, I think there could, and should be a great simplification of the procedure relating to the settlement of reserves. Once it is conceded, that there are no grounds for the assumption that villagers can acquire legal rights, it is possible to substitute some simple procedure merely for the purpose of ensuring that villagers affected by reservation shall receive fair play. Before an area is proposed for reservation, the whole area, and more particularly the portion adjacent to villages and cultivation, is carefully examined by a Gazetted Forest Officer, and seeing that he is empowered to record evidence on oath, it would be insulting to deny that he is sufficiently trustworthy to make an accurate list of persons or villages affected by reservation or to record their requirements.

It is a tradition in Burma that all Forest Officers are oppressive, and that they are so anxious to develop and improve their reserves that they are inclined to disregard the interests of villagers affected by reservation, but the tradition has only arisen out of the repugnance of Forest Officers to admit prescriptive rights. I think most Forest Officers are anxious to retain any small villages in an inaccessible and difficult tract of forest, and to enlist the support and co-operation of persons living in villages close to a reserve, and provided that the question of prescriptive rights did not arise, but only concessions, given as an act of grace, which could be modified or extinguished as economic conditions change, would be willing to give villagers practically all they wanted. Provided that a trustworthy record had been obtained of all villagers affected by reservation and of their requirements, and provided that the Forest Department was willing to authorise existing practices, and not to modify or cancel such concessions without the approval of the Commissioner, it would be difficult to

justify further formalities, and in particular any enquiry on the spot by an overworked Civil Officer. Only in cases of dispute would it be necessary to provide, that a Civil Officer should be deputed to hold an enquiry on the spot, and to arbitrate between the Forest Department and villagers. But if it were the policy of Government to restrict reservation to what may be called superfluous forests, and to avoid taking up an area, the reservation of which would cause hardship and discontent, Forest Officers would be bound by this policy, and would refrain from submitting proposals of a contentious nature. By the adoption of some simple procedure, such as that proposed, great economies could be effected, and it would, I think, be possible to complete reservation throughout the Province at a very early date.

It is natural that villagers and townspeople through the agency of local traders, should obtain their requirements from the easiest and most accessible forests, and it is inevitable therefore that these forests which merely contained ordinary jungle growth should be impoverished, by the persistent removal of anything of value, and the survival of unfit. The impoverishment of these forests has been causing great anxiety and inspired Sir Reginald Craddock in his famous Minute on Forest Policy to state that their " preservation is absolutely essential to the maintenance of the agricultural community." On that assumption he formulated a policy the basis of which was to divide these forests between village communities and the Forest Department, with the intention that, so soon as village communities had completely denuded the " village waste," they would be forced to obtain their requirements on payment from the areas allotted to the Forest Department. He concluded his proposal with the statement that, " EX-HYPOTHESI, the forest reserves will be amply adequate for the forest needs of the country, both the present and succeeding generation." Practically the same policy has I believe proved successful in the Central Provinces, and in view of the fact that this policy has been approved by a Conference of Commissioners and Conservators, it may seem presumptuous on my part to offer any adverse criticism. As a Forest Officer, however, I am not prepared to admit that the preservation of the more accessible forests, " is absolutely essential

to the maintenance of the agricultural community," or to accept any policy based on that assumption, for the simple reason that, these forests have already been denuded (*hinc illae lacrimae*), and that, no amount of conservation would ever restore their value. I am however convinced, that the objects which His Honour had in view, could be attained very much more readily, by resorting to a policy of afforestation. The reservation and consequent preservation and conservation of inaccessible forests cannot appreciably benefit the rural communities. To be of any real use, supplies for villagers must be cheap, and owing to the high cost of transport, these supplies must be grown close to the place where they are to be utilised. Steamship and railway companies also require large quantities of firewood at a reasonable price, and it is urgent that we should cater for these demands not so much because if they are forced to use coal they may be obliged to put up their rates, but because their demands accelerate the destruction of the more accessible forests. The climate and soil are favourable to tree growth, and produce required either by villagers or large companies can be grown very cheaply in plantations, but the one essential is to obtain sufficient land for the purpose close to the place where the produce is to be utilised. There are large areas of Government waste land available and suitable for this purpose, and if my contention is admitted that such land and all the produce thereon is the absolute property of the Local Government, there is legally no reason why such land as may be required should not be handed over to the Forest Department. From a common-sense point of view it is obvious that, when a tract of waste land is planted with a crop, fenced in, or otherwise occupied, it ceases to be waste land, but this change of status is not recognised under the Burma Forest Act. Under Section 33 the public is authorised to use practically free of restriction any produce found on "public forest land" which is defined as, "land at the disposal of Government and not included in a reserved forest." Legally, therefore, any person may use free of restriction, the fuel found on the land, included in the compound of any Government building, or may pasture his cattle on land planted by a squatter, who has not acquired the status of land owner. In order to protect the produce

grown in these plantations it would, therefore, be necessary to amend the definition of public forest land, and incidentally bring it into line with commonsense. The effect would be that, any plantation would automatically be exempt from the privileges conferred under Section 33 of the Forest Act, and be protected under the Penal Code in the same way as crops grown by squatters. In order to obtain the benefit of Section 52, which prescribes that all forest produce should be presumed to be the property of Government, it might however be preferable to protect these plantations under the Forest Act. I have already suggested that Sections 5 to 24 of the Forest Act should be amended and the procedure simplified, and if the proposal were accepted, it would at the same time be possible to provide that a reserved forest be constituted, either by a process of notification, or by a process of bringing an area under cultivation.

Apart from the legal question, it is however necessary to consider, whether the formation of plantations, to the produce of which no rights would be admitted, would interfere with existing customs and practices, and would cause any real discontent. An Indian coolie if he wishes to acquire any land, merely has to clear it, plant a crop, and provided he continues to cultivate a crop and pays land revenue for 12 years, he thereby acquires "the status of landholder." From the outset he has an undisputed right to the crops he cultivates, and in the case of damage could invoke the protection of the law, and although he is depriving an adjacent village community of a limited amount of forest produce which was previously derived from the area, his action arouses no sense of injustice. In some districts villagers are already, I believe, paying as much as Rs. 20 for a *pyinkado* house post, and elsewhere, their fuel supply is endangered by the competition of railway and steamship companies, and if the Forest Department attempted to satisfy these demands, and out of the thousands of square miles available selected here and there a few hundred acres for planting, why in the name of goodness should any person feel aggrieved? As a matter of fact an enterprising Divisional Forest Officer has already started making plantation on public forest land in the expectation that, before the trees attain marketable

dimensions, some action will be taken to protect them, and his action has aroused no hostility. On the contrary, the villagers have realised the benefit, as the money they receive for planting and weeding these plantations and the exemption they receive from taxation has greatly improved their position, and they are cordially co-operating with the Department. It might be possible to engineer a certain amount of discontent by distributing, broadcast, proclamations calling upon every villager for miles around to submit claims against the Department, and by suggesting to them, that they would have a grievance if their claims were not admitted, but if the Department dropped all such formalities, and went steadily to work to supply the needs of the future, why should there be any difficulty? In all countries people seem to think that they have a moral right to help themselves to the wild produce of nature, and in the same way that an Englishman feels aggrieved when he is debarred from picking mushrooms, so also a Burman feels aggrieved, when a tract of jungle from which he has been accustomed to obtain his requirements is closed to him by reservation. But, because an Englishman is accustomed to pick wild violets in a hedgerow, he does not consider that that justifies him in picking violets which have been planted in a garden, and similarly there is no reason why a Burman should consider that he has any claim on produce grown in a plantation.

The policy which I am putting forward for consideration is simple and straightforward. In the first place I propose that reservation in the usually accepted sense of the term, should be restricted to areas which, for one reason or another, have been left untouched by villagers and local traders. These forests are becoming known as "commercial forests," and serve a useful purpose in yielding a supply of large sized timber for export, and are the mainstay of our revenues. Incidentally I propose that the procedure relating to the settlement of these reserves should be simplified so as to complete reservation, which is not a popular process, as soon as possible.

In the second place, I propose, that we should attempt to cater for local demands by forming plantations. To some extent, it may be possible to meet these demands by bringing the more

accessible portions of our main reserves under the uniform system, but I am convinced that our existing reserves are inadequate for the purpose, and that instead of acquiring more land by the ordinary process of notification, it would arouse less opposition to adopt the expedient of planting up suitable areas and thus establishing occupation.

Finally, I would deprecate acquiring more land than we can effectively manage, or than is necessary for supplying the present and future needs of the Province, and would recommend imposing as few restrictions as possible in respect of the produce grown on Government waste land. With a steadily increasing population and improved methods of communications, we may rest assured that waste land will gradually be taken up and utilised to good advantage, but in the meantime this waste land serves a useful purpose in tiding over the transition from the stage when practically every villager could obtain his requirements from an adjoining jungle free of charge, to the stage when every person will have to purchase his supplies in the open market and, as in more advanced countries, will have to rely on produce which has been as carefully cultivated as any field crop.

H. C. WALKER, I.F.S.

THE INFLUENCE OF THE HAND OF MAN ON THE DISTRIBUTION OF FOREST TYPES IN THE KUMAON HIMALAYA.

The following observations are based on experience of the central parts of Kumaon from Dudhatoli and the head-waters of the Pindar River, down to the plains between Ramnagar and Tanakpur :—

There is but little difficulty in distributing the forest area in this section of the outer Himalayan hills among the following types according to the dominant species :—

(1) Sal (*Shorea robusta*), (2) Low-level miscellaneous, (3) *Chir* (*Pinus longifolia*), (4) *Banj* (*Quercus incana*), (5) *Moru* (*Q. dilatata*), (6) Kharsu (*Q. semecarpifolia*), (7) Silver Fir (*Abies Pindrow*).

Neither deodar (*Cedrus Deodara*), spruce (*Picea Morinda*), nor blue pine (*Pinus excelsa*) occur naturally in this area, and so are omitted from consideration.

In the most general way, altitude appears to be the most influential factor in deciding which type shall occur, though the first and last of the seven types occur most commonly as islands in the adjoining ones. At the same time, it is clear that such zonation as can be recognised, is not merely the direct result of altitude as such, but is due to the physical conditions altitude implies, when combined with the given local physiography. Thus, for the same elevation to carry the same forest type, similarity of aspect and exposure, and to a minor extent, of sub-soil and gradient, may be required.

A detailed study of the factors which bring it about that, a given tree species predominates on a given spot, is one of great interest and importance to the forester and the botanist, and more or less information has been collected and published for the trees here in question, though a vast amount of work remains to be done (see especially TROUP,[1] pp. 17, 18 and 67). The special aspect which it is proposed to consider more in detail here, is the effect which the pressure of population and all that it involves, has upon the distribution and interaction of the seven forest types enumerated above.

The parallel problem for the vegetation of the plains has been recently investigated by DUDGEON[2], and much of what he writes is applicable, *mutatis mutandis*, to the forests now under consideration. Scattered references to the subject will also be found in the working plans of the various forest divisions in the Himalaya, published in recent years.

For a clear understanding of the matter, the main characteristics of the tree species concerned must be brought together and considered in their bearing on it.

1. *Sal.*—Normal altitudinal range, 1,000′ to 3,500′. In these hills, a small and relatively unimportant part of the total natural area of distribution is sal, where this species occurs at all, it occurs gregariously, and more than that, frequently occupies cent per cent of the crown space to the practically total exclusion of other

species; in this it contrasts strongly with the following low-level miscellaneous type. One frequently finds cases where it has apparently obtained an entry into the miscellaneous forest, and has extended and is still extending at the expense of the latter. As sal, such forest may be of third or fourth quality class, but nevertheless it can compete successfully with the other trees growing under what look to be optimum conditions for them, and finally exclude them.

Sal, then, clearly possesses some special innate characteristics which enable it to behave in this way, making it appear to be the climax formation for considerable areas at present under miscellaneous forest. It is not to be imagined however that sal can ever clothe much of the outer slopes of the Himalaya, since a very large proportion of the area is beyond question at present, far too xerophytic and unstable. The special characters of sal which may contribute to its gregarious and aggressive habit are:—

(*i*) Powerful coppicing ability, whether cut back or burnt back.

(*ii*) Production of abundant seed adapted for near disposal only.

(*iii*) Immediate germination of seed with large food reserves.

(*iv*) Power of the seedlings to persist under the old trees, or any adverse conditions, for a long period, till the opportunity to shoot up arises.

(*v*) Heavy shade cast by the broad spreading crown in maturity.

(*vi*) Heavy leaf-fall killing out foreign seedlings and undergrowth.

(*vii*) Narrow crown and rapid growth in youth, enabling it to push up among competitors.

(*viii*) Longevity.

2. *Low-Level Miscellaneous* (1,000′ *to* 4,000′).—This type differs from all the others in comprising instead of a single species, an aggregate of some 25 really abundant, and 25 more fairly common species, together with a large number of

less generally conspicuous forms. KENOYER[3] calls it the *Bauhinia* formation, but the *Bauhinias* are commonly of less importance than in the restricted area dealt with by him (Sat Tal valley).

The inter-relationships of these species are in general extremely complex, and as a matter of fact are not of very great importance, at least to the professional forester; almost any given species, even including many of the rarer of them, may, for no obvious reason, predominate over a fairly extensive area, but as a general rule, one finds a mixture by single trees, or quite small groups. This might be due to various causes such as :—

(*i*) The absence of any single species endowed with those favourable characteristics which enable it gradually to oust all other species from its vicinity.

(*ii*) The variation of the ecological conditions in this zone being so great, that no one species could occupy the whole area, even if freed from competition with the others.

(*iii*) The struggle against edaphic conditions outweighing competition between species.

(*iv*) Intolerance of the offspring of the several species for ground recently occupied by the same species.

The zone is a very definitely xerophytic one, with intense insolation and drought in the hot weather, and available moisture commonly depends on small variations in depth of soil and in aspect, so it is probable that the last mentioned possibility is of less weight than the others. (ii) and (iii) are closely connected, and undoubtedly of considerable local significance, but for the type as a whole, the first mentioned factor is the most influential. In other words, the balance among all the species in their competition, one against the other, is so equal that ordinarily no single one of them appears to be able to extend its area appreciably at the expense of the remainder.

3. *Chir* (3,000′ *to* 6,000′).—There are few natural forests in the world as 'pure' as the *chir* forests of the Himalaya, and this species, like sal, must be endowed with special advantages to enable it so completely to oust its competitors. So complete is its success that it is possible to find thousands

of acres virtually unbroken, in which no other tree reaches the main canopy, or indeed, in some cases, is to be found at all (*e. g.*, the vicinity of Bageswar in the upper basin of the Sarju River). Special features worth enumeration (to be compared with those for sal) are:—

(*i*) Coppicing power, unusual in conifers, of young plants of 2—10 years of age, whether cut or burnt.

(*ii*) Periodically heavy seed production adapted for wide dispersal on the hill-sides.

(*iii*) Ability of small seedlings to bear a good deal of shade.

(*iv*) Very rapid height growth in youth.

(*v*) Heavy needle-fall obstructive to the development of all other species, especially on dry exposures where decomposition is slow.

(*vi*) Resistance to fire of the larger trees unequalled by any associate.

4. *Banj* (6,000′ *to* 8,500′.)—The *banj* oak may, under special conditions to be mentioned later, occur in absolutely pure stands, but it is most usual for it to appear as about 60 to 90 per cent. of a mixed forest in which *Rhododendron arboreum* comprises the major part of the remaining 40 to 10 per cent. This latter tree has as special characteristics, an enormous seed production, very pronounced shade bearing power, and inedible or poisonous foliage, sufficient to account for its prevalence: its inter-relationships with *banj* would make an interesting study. The assets with which the *banj* works are:—

(*i*) Very pronounced coppicing power of the younger trees.

(*ii*) Heavy shade and wide spreading crown of the mature tree.

(*iii*) Longevity.

(*iv*) Adaptability to a wide-range of edaphic conditions.

This is not a long nor particularly imposing list, and as will be seen, there are some serious weak points affecting it in the opposite direction in the struggle for existence and dominance, but it is apparently sufficient under the prevailing conditions of competition, and *banj* is the climax formation in the zone in which

it occurs, and for parts at least of the zones below it. It may further be noted that *banj* is unable to maintain its first place on soils with high water content, but this is an uncommon feature in these hills. The *rianj* oak (*Q. lanuginosa*) formation included in it, is interesting but as a minor matter cannot be discussed here.

5. *Moru* (7,000′ *to* 9,000′).—*Moru*, or *tilonj*, is a far more exacting species in its requirements as regards conditions of habitat, than any of the foregoing, and although exhibiting many xerophytic anatomical and phenological features to tide it over a dry relatively hot season, is mainly mesophytic. It has accordingly a more restricted range, a less defined sphere of predominance and occurs more freely mixed with other species though only those of the zones next above and below, and sometimes silver fir, seriously compete with it. Especially as regards depth of soil and moisture it is exacting, but suitable conditions are common enough on sheltered aspects and in hollows for it to form an important and conspicuous type. It is comparable in many ways with sal (though belonging to a totally different flora), as will be seen from the following list of characters considered as most effective in assuring it the place it occupies :—

(*i*) Considerable coppicing powers, especially when young.
(*ii*) Periodic heavy seed production adapted for near dispersal only.
(*iii*) Immediate germination with large food reserves.
(*iv*) Power of seedling to establish itself under considerable shade.
(*v*) Heavy shade cast by a wide spreading crown at maturity.
(*vi*) Rapid height growth in youth.
(*vii*) Longevity.

6. *Kharsu* (8,500′ *to* 11,000′).—This oak possesses some of the features of *banj* and some of those of *moru*. In seasonal history and habit of growth it is very similar to *moru*, but in its far less exacting demands on the locality comes nearer to *banj*, in fact on dry exposed ridges, the *moru* zone is absent, and *banj* and

kharsu meet (but hardly overlap). Similarly *kharsu* occurs in very pure crops, often 100 per cent. or so.

7. *Silver Fir* (7,500' *to* 10,000').—In its requirements, silver fir comes very close to *moru*, but would appear to require even more moisture and shelter from insolation and drought, and so competition between them only occurs in the best localities. Very frequently it is exclusively restricted to sheltered northern aspects, where it forms more or less pure forests in the upper part of what would, in its absence, be included in the *moru* zone. The silver fir has several handicaps as an aggressive species, especially in its extreme sensitiveness to fire and drought, but it also has some important advantages, *e.g.*—

(*i*) Maximum shade bearing powers especially in early youth.

(*ii*) Rapid height growth and narrow crown in youth.

(*iii*) Dense shade and heavy needle and twig fall of the maturing tree.

(*iv*) Longevity as compared with all other competitors except the oaks.

(*v*) Great height at maturity, assuring dominance, once the crown is free.

The high level deciduous formation, with maples, *Prunus Padus*, etc., is intimately connected with the silver fir, but being relatively unimportant in these forests, is not further discussed.

Geologically considered, the Himalayas are young mountains (though the constituent rocks are of course mainly very old), and the changes consequent on their gradual and relatively rapid erosion must be always taking place. The outer ranges, composed of but little metamorphosed or consolidated Siwalik rocks, are exposed to the maximum weathering effects by sun and monsoon rain, and are accordingly very unstable in their upheaved position. In the inner ranges of mostly hard crystalline rocks, these changes are so gradual as to be almost imperceptible to us, and an equilibrium appears to have been reached. However, the general nature of the effect—slight, may be, but cumulative—of the vegetative covering on a locality, is well known, and this equilibrium is often only apparent ; there must be a constant if

not too obvious progression or fluctuation at the limits of the forest zones mentioned although each or at least the majority of them would appear to be of the nature of a climax formation in its own range.

Of recent years, recognition of the disturbance of this apparent equilibrium caused by the introduction of organised forest management with its inhibition or curtailment of firing, of indiscriminate lopping and felling, and of unrestricted and unregulated grazing, has forced itself on the attention of forest officers, and finds expression in attempts in working plans to affect the position of the equilibrium in a direction favourable to the objects aimed at, in the management adopted. In particular, the effect on the relative distribution of the several conifers—*chir*, *kail*, deodar, etc.—both in competition with one another, and with the less valuable broad-leaved species (TROUP[1], p. 17-18; SMYTHIES[4], p. 16; HOWARD[5], p. 11; TREVOR[6], pp. 16 and 18) has been frequently remarked on, though the matter never appears to have been as thoroughly investigated as it deserves. To express the matter differently, we have come to realise that the present equilibrium is very profoundly influenced by the hand of man, and that on the removal or restriction of that influence, the vegetation has to shift over to a new equilibrium position, which is liable to take at least as long to attain as the existing one has taken, and certainly a period extending over several tree generations. The further changes the forester brings about with organised fellings, cleanings, etc., are in a different category and their study comes under that special branch of ecology known as sylviculture and so will not be here further followed up. An appreciation of these changes following on "protection" of the forest, also helps one to realise better the effect which the unregulated reaction between man and his herds, and the forest, has produced and is always continuing to produce on the latter.

It is known (ALMORA GAZETTEER[7], p. 163–5) that Kumaon has supported a considerable population for the last 1,000 years at least, and at present there is hardly an acre of land which can be irrigated or can carry a fair field crop under cultivation with or without terracing, which has not been occupied When moving

in these valleys, one is always wondering what the vegetation must have been like before the advent of man. A definite answer can only be given for the areas taken up in the last 60—70 years for tea and fruit estates ; these do not occupy the valley bottoms, and are usually obviously new clearings in the *banj* and upper *chir* zones.

For present purposes, the effects of the hand of man on the forest may be dealt with under the following heads, in probable order of significance :—

(*i*) Burning of the forests, annual or periodic.
(*ii*) Felling of the trees for fuel and timber.
(*iii*) Lopping for fodder or manure.
(*iv*) Trampling of the soil by cattle.
(*v*) Browsing by cattle.
(*vi*) Removal of litter.

The effects of each of these adverse influences on the position of the equilibrium between each pair of the forest types already distinguished, may now be examined, as also their effects on each type within its own territory.

1. *Sal—Low-level Miscellaneous.*—Sal has a thick dry bark and is very resistant to destruction by fire. Young sal readily coppices when burnt back, in fact in its earliest stages, fire, by removing the injurious carpet of dead leaves (HOLE[8], p. 81), and by giving a growing season free from shade and competition from herbaceous and shrub growth, is probably actually helpful to sal. It thus appears that given suitable edaphic conditions, firing will ultimately help sal against possible tree competitors, for none of its associates possesses these features in equal degree. Given time, sal appears to be able to establish itself even as a complete crop, despite annual or periodic firing. In established crops safe from fire injury, a fire in these hill areas, even after years of successful protection only consumes the fallen leaves, and does little or no harm to the standing sal. At the same time it has to be realised that by slowing down or even altogether inhibiting the natural progression from xerophytic to mesophytic conditions, burning must ultimately restrict the area which sal

would otherwise occupy (since most of its competitors are more adapted to xerophily than itself). It is worth noting that one of the commonest associates of sal in these hill forests, namely *Buchanania latifolia*, is extremely fire tender.

Its great coppicing power is certainly the reason for the existence of almost pure sal where the axe and bilhook of the villager falls most heavily, as in the densely populated valleys at the upper limit of the species (*e.g.*, below Bhatronjkhan, and Dabra and Maiduri Reserves, all in Ranikhet Forest Division). As a result of incessant lopping and cutting, all other species have been exterminated, only sal being able to survive the treatment meted out. Thus these forms of injury also must tend to favour sal, as against its associates. The trampling of the soil consequent on heavy grazing may shift the equilibrium in favour of the miscellaneous in two ways. Firstly whenever the soil is at all stiff, it becomes very hard and badly aerated, conditions which sal cannot easily contend with ; secondly, where it is loose, stony or unstable, the trampling results in increased exposure and drying out, and hence acts as a check on the extension of the more mesophytic type. Sal is considerably browsed, but its coppicing power enables it to withstand destruction better than other species subject to similar treatment whilst its other advantages enable it to compete successfully with such as escape lopping. Removal of leaf litter is probably of less far reaching importance, but acts in the same directions as trampling. Hence the conclusion that man's influence is on the whole (leaving out the possible local case of wholesale fellings) in favour of extension of the sal as against the miscellaneous species, where not so severe as to destroy both together.

2. *Sal—Chir.*—It is not rare for sal and *chir* to overlap, though as a rule the sal is then of very inferior quality owing to over-rapid draining off of the rainfall and similar factors. The tendency is for the sal and its associates to form a complete understory to the *chir*, preventing the regeneration of the latter tree, though its adaptability and rapid height growth will usually enable it to maintain a footing, if no more. Fire protection encourages

the formation and extension of this undergrowth, but at the same time aids the natural regeneration of the *chir*, and examples can be found where now one and now the other of these two effects has predominated. For Naini Tal Division SMYTHIES[4] (p. 10) writes, that the *chir* is gradually monopolising the ground as a result of prolonged protection. Lopping, browsing and felling all fall primarily on the sal where sal and *chir* occur together.

Thus the effect on this equilibrium varies with local conditions, but where the hand of man rests heavily, it is usually to the disadvantage of the sal.

3. *Low-level Miscellaneous—Chir.*—The competition between *chir* at its lower limits and the low-level miscellaneous type is deserving of more attention than has been given it. There is generally a tendency to assume, that the *chir* disappears owing to inability to thrive under the temperature and insolation conditions prevailing below say 3,000′, and that competition with other species hardly enters into the question. *Chir*, however often grows very vigorously when planted at low elevations (as at Dehra Dun). KENOYER[3] (p. 245) is none too precise on this point, but seems inclined to the view that the pine tends to be pushed back by the *Bauhinia*, etc. This is not in agreement with what may be seen elsewhere, that fire protection, by enabling pine seedlings to establish themselves, results in an extension of this species, though usually only in open canopy. TROUP[1] (p. 18) emphasises this downward extension as a conspicuous result of fire protection. It is a curious fact that the pine appears to extend furthest downwards as well as upwards in altitude, along exposed ridges (Bhatronj), and this has also to be co-ordinated with its relative rarity on the outermost south facing slopes of the Himalaya. Its many xerophytic adaptations unquestionably play an important part, but there must be other factors also at work. In Naini Tal division, the miscellaneous type predominates on volcanic rocks on a S. aspect where *chir* apparently cannot get or maintain a footing :— the same occurs on very unstable slates and shales [SMYTHIES[4] (p. 9)]. OSMASTON[9] (p. 20) gives as his opinion that even under fire protection, *chir* will never extend its range any distance into the miscellaneous type in N. Garhwal.

Summarising, very little is known concerning this case, but it would appear that restriction of man's influence acts in the direction of extending the area over which *chir* predominates.

Within the low-level miscellaneous zone, there is no question but that human activities act in preventing the closing of the canopy, and improvement of the soil, and in favouring the more fire-resistant, the more freely coppicing, and the more light demanding species as against the opposite classes, but no precise details are available.

4. *Low-level Miscellaneous—Banj.*—In sheltered aspects and hollows, *banj* and low-level miscellaneous forest sometimes come into contact, but at the relatively low elevations concerned, the moisture and other requirements of the evergreen oak, are too rarely fulfilled for serious competition to result. When it does, it would appear (as Kenoyer found) that the oak will encroach on the miscellaneous when aided by protection from injury.

5. *Chir—Banj.*—This contact is by far the most important to the forester and is relatively simple to study, since practically only these two major species are concerned. The result of checking the interference by man with the balance between the two species, is easy to see in any area within suitable altitude limits, which has been under protection for any length of time. The oak extends downwards from above, and outwards from the ravines and hollows (down which in present conditions it may extend right through the *chir* zone down to the low-level miscellaneous) into the area previously exclusively under *chir*. This extension takes place relatively rapidly in the form of a more or less complete undergrowth—in which admittedly *Cratægus*, *Myrica*, etc., are also abundant—which conserves the moisture of the soil and adds to its depth and humus content. The existing *chir* undoubtedly benefits from this improvement of the soil, but its regeneration is almost completely inhibited, and where under former conditions a pure crop of *chir* seedlings might have grown up to replace in time the old crop, now there will only be a few *chir* poles struggling through and dominance will have gone over to the more mesophytic oak. If from any cause the *chir* overwood is felled in such places, the change which if left to nature would take at least

a *chir* generation, may be completed in 20 years as can be seen in not a few places. This shifting of the oak-pine line resultant on the protection of previously burnt and maltreated forests, has certainly taken place in the opposite direction and much of the territory now being invaded by the oak must have originally been under oak ; by recommencing exclusion of man's interference in this direction, we see once again the standard progression towards a more mesophytic vegetation. Many examples might be quoted where examination on the spot convinces one, that long continued lopping and felling of oak and its broad-leaved associates and the resultant drying out of the soil, has driven these species back till they are confined to very narrow strips along the water-courses, etc., where natural conditions enable them better to maintain their struggle for existence. It requires analysis to decide how much of this change is to be ascribed to protection from fire, and how much to protection from lopping, etc. Oak and its associates can only invade new territory as seedlings and the seedlings stand a very small chance of survival in the strong ground fires in the carpet of pine-needles and grass; at the best, they stand no better chance than the *chir* itself. Browsing will affect the broad-leaved species far more than *chir*. It has been seen that lopping although concentrated on the oak, will usually not exterminate it, but it will often just make that difference which will enable the *chir* to maintain its dominance. It may then be concluded that under average conditions, fire is the chief agent in this matter.

There is however an interesting inversion of the process, where the pressure of the population is very intense on an area moderately well suited to both species. Removal of fallen leaves and needles for litter and manure, and heavy grazing, greatly reduce the fire hazard, so that felling and lopping become the chief factors. In such places, *chir* is freely lopped for litter, and sooner or later succumbs ; moreover, the large *chir* trees gradually disappear, whether felled for shingles or overthrown by wind perhaps breaking through an old fire wound—and the smaller poles especially are felled for building purposes. Meanwhile, the oak is lopped bare every spring, and browsed constantly, but such are its powers of resistance that it survives where the *chir* is destroyed

and in the end the *chir* forest has been replaced by scrub oak. Very many examples of this could be quoted and all stages of the process can be seen : especially interesting are those cases where it has resulted in an inversion of the normal zoning, the oak being found below the *chir* (Katarmal near Almora, Sarna near Bageswar).

To summarise, the effect of the population on these forests has been, and is, to extend the area under *chir* on a large scale, but to replace *chir* by *banj* over small areas as a stage towards the total destruction of the forest cover.

As regards the effects on the *chir*, where its predominance is undisputed by other species, the following points may be noted. The maximum pressure on the forests and on the land generally in these hills is exerted on the *chir* zone, and almost the whole cultivated area excepting the actual valley bottoms must have been in the first place under *chir*. The stages of the destruction of the forest, unfortunately still all too common, are worth at least passing notice—not the mere clearing of an area for the express purpose of cultivation as is seen in the many *chaks* in our forests, but the gradual often unintended and unrealised destruction which results finally in those bare soilless hillsides which so disfigure Almora itself, and are being ever extended at the present day. This destruction, the consequences of which the whole Pali *pargana* (to quote a specific example) has long felt to its detriment, represents an economic loss far beyond all proportion to any gain which may have been obtained during the process. In practice, though certainly not necessarily, the most serious demand in the long run of a big population on the forest is for firewood—most serious because it is easier to cut down a small tree, or lop a bigger one, or trim off its branches after felling it, than to cut up the big log of a tree which has reached the end of its natural term of life. This means that regeneration is totally prevented, and as already noted, *chir* must ultimately disappear. If broad-leaved species still survive, their turn comes a little later, when it becomes easier to cut up a tree nearby than to go a greater distance for more easily obtained fuel and the incessant lopping and browsing becomes too much for them. The end is

the annihilation of the forest. Erosion has been in steady progress during these processes, and is hastened by the continued grazing, and the soil is lost and the last stages, as all round Almora*, is treeless almost shrubless waste, on which intensive working in enclosed plantations can with difficulty raise but a third or fourth quality crop of *chir*, where formerly, a first or second quality one must have existed.

In the foregoing paragraph no mention has been made of the effects of burning. OSMASTON[10] has described the damage done by fires to the chir forests in N. Garhwal and the account applies elsewhere. His estimates that in unprotected areas 20 per cent. of the trees over 3′ girth are seriously injured by fire and that about ten trees per square mile fall annually from this cause, are of special interest. It is doubtful if TROUP'S (p. 68) statement that *chir* forests may revert into bare grassy slopes through burning, can be substantiated without calling in other destructive agencies for the later stages.

Examples can be adduced in plenty, demonstrating that patches of *chir* regeneration can succeed in surviving annual burning and in establishing themselves well enough to be safe from further serious injury from a continuance of the process. From present appearances, it is very difficult to believe that the existing sometimes fairly complete and regular older crops have come up under such conditions, but it must be accepted as a fact that to a large extent, they must have done so. The patches referred to are very commonly found round cattle stations and villages, the reason apparently being that in such places light has been let in by casual fellings and there is little accumulation of needles and growth of grass, so that fires are either very light, or do not spread everywhere, and so give the seedlings that one or two years' start they require to become sufficiently established to survive subsequent fires SMYTHIES[11] has contributed an interest-

* It is stated that a part of this at least, was purposely disforested by the Gurkhas on military grounds for the easier defence of the town as the capital of Kumaon

Cf.—Almora Gazetteer[7], p.239. In the sixteenth century the ridge was covered with thick forest.

ing study of this subject (cf. TROUP[1], p. 70) giving as his conclusions, that after years of burning, fire protection gives an extraordinary and universal stimulus to regeneration, that successful regeneration is possible under the most favourable conditions without fire protection, and lastly that long continued protection resulting in a thick soil covering, has an adverse effect on further regeneration. Although it must thus be admitted that fire does not totally inhibit regeneration of *chir*, there is no question but that by greatly restricting its amount, the selective onslaught of the villager on young poles is rendered the serious matter it is; given fire protection, young poles and saplings come up in such numbers that all possible requirements and more could be met from desirable thinnings only.

Left to itself with reduced or no grazing, etc., the wastes thus denuded and eroded, develop a thorny scrub of *Berberis*, *Crataegus*, *Pyrus*, etc., and *chir* soon once more makes its appearance, fire is of no importance at this stage and very gradually, at a rate depending on a couple of local factors, *chir* will in the end resume its sway, crowd out the scrub, and after perhaps four or five generations, undisturbed, say about 600 years original conditions would be re-established. Some parts will almost certainly revert to the low-level miscellaneous type in the beginning and the process of the re-establishment of *chir* will be even slower.

One curious characteristic of *chir*, *viz.*, its tendency to develop twisted fibre under ill-treatment is noteworthy as acting towards retarding the processes of destruction; in many intensely maltreated forests, the fibre is so intensely twisted that the wood becomes very difficult to split, and trees so affected, being worthless for timber or shingles, and not repaying the toil required to break them up for fuel, are left alone where normal trees would be destroyed. If the indications which can be adduced to show that this tendency has become established and heritable, are correct, then this selective action has resulted in a permanent alteration which the extension of protection alone, can never rectify.

As regards the immediate effects of grazing on *chir* regeneration it seems agreed, that light grazing may be beneficial in keeping down coarse grass, etc., and facilitating access for the seed to the

mineral soil, but anything like heavy grazing can almost inhibit regeneration (cf. HOWARD[5], p. 14). Buffalo grazing is certainly very injurious to small *chir* since these animals freely browse the young shoots.

6. *Banj—Moru.*—As already mentioned, the *banj-moru* line is not too well-defined. Like *banj*, *moru* is exposed to every form of injury from the villager, and only suffers less as it is commonly more remote from the centres of population. Since however it has been seen that *moru* is exacting in its demands on its habitat, the opening up by lopping and grazing, by inducing a drying out of the soil, has undoubtedly restricted the range of the *moru*, though its powers of regeneration stand it in good stead. The complete change in the undergrowth following heavy lopping, which is a good indication of the processes at work, is well seen on the slopes of Duthatoli; thus bracken fern which is never seen under virgin *moru* forest becomes a conspicuous constituent in such places. *Banj* as a hardier and less exacting species, and such trees as *Pyrus Pashia*, *Euonymus tingens*, etc., become predominant where *moru* is eliminated, whilst most of the characteristic associates of the latter such as *Ilex*, Æsculus, etc., disappear with it.

When the destructive influences in *banj*, or *moru* forests are powerful enough to result in the destruction of the forest as such, the *banj* areas usually degenerate into scrub growth with the surviving coppice stools of unknown age left on stilt roots owing to rapid erosion of the now exposed soil with a high proportion of thorny shrubs such as *Cratægus, Rosa, Pyrus, Berberis*, etc., and the final stage is bare land with sparse grass and thorny bushes. When once more protected, the shrubs increase in density and height, tree species, especially the quick growing *Pieris* slowly replace them, and finally *banj* once more resumes its sway. As already noted in the sunnier and drier parts, *chir* may form a transitory stage, and *banj* will usually precede the re-establishment of *moru*. All these stages all well seen to the east of Almora in Morpateuri, and also in various parts of Bhatkot and Dudhatoli. OSMASTON (p. 23), records that in North Garhwal it is often possible to trace how the oak forests have receded from the villages.

In clearings in the *moru* zone, a shrub growth of *Rubus*, spp., *Indigofera* and *Spiræa* replace the regular undergrowth species, and remain as a permanent formation so long as the destructive influences are at work; on the removal of these, there is a relatively rapid reversion to oak forest.

In both *moru* and *banj* forests, the damage done by lopping and felling is concentrated on the oaks, which are accordingly at a disadvantage compared with other species so long as the pressure is not so great that they also, though admittedly inferior for fodder or litter, get lopped—in which case the far superior coppicing power of the oaks is called into play. This influence is more usually seen in the strips of oak forest running through the *chir* zone where this selective lopping may result in the dominance of *Rhododendron* and *Pieris* (*e.g.*, Jaikhal); as a rule, however, the superior vitality of the oaks enables them to maintain their predominance despite such selective ill-treatment.

Fire is usually not so important a factor in these forests as in *chir*, though it is probably largely responsible for the very open condition of the crop on southern exposures. *Banj* is fairly resistant when mature, and young trees usually coppice when burnt. The *moru*, being confined to a moister habitat is less exposed, but is a good deal more tender in its young stages, the dense thickets of young saplings being especially liable to destruction by fire (China, Naini Tal). On general grounds it can safely be asserted that burning must reduce the area under *moru* and *vice versâ*.

7. *Moru—Kharsu.*—The extent to which *kharsu* is lopped depends a good deal on local factors, *e.g.*, in N. Garhwal (OSMASTON[9], p. 22) it is often very severely treated, but elsewhere it appears to be less lopped than the other oaks and may sometimes be seen unmolested where *moru* with difficulty maintains its hold. Fires are equally destructive to both, on the occasions when they sweep up from the *chir* zone, but in their general effect on the locality must favour *kharsu* as against *moru*. Cleanings in the *kharsu* forest seem to be very slow in filling up perhaps owing to the tendency of snow to drift into the holes formed. It may be noted that one effect of grazing

in these forests is the extermination of the undergrowth of ringals (*Arundinaria*) which may otherwise be very dense, even to hindering oak regeneration.

The practice of shifting cultivation (without terracing), or *katil*, has been most widespread in the *moru* zone, where the fact that only a single crop can be produced annually involves a larger area under cultivation per head of population. Ordinarily, the land is not given time to revert to oak forest before being cleared again. Good examples may be seen in the upper parts of the Pindar Valley.

8. *Silver Fir.—Moru and Kharsu.*—Silver fir suffers from several handicaps in its competition with the oaks. Thus it is extremely fire-tender, has no appreciable coppicing powers, is the only easily worked timber tree in the areas where it occurs, and is the most exacting on the locality of all the species here under discussion: the graziers also have a destructive habit of stripping large slabs of bark from green standing trees, leading to rot and windfall. Its one great advantage, which to all appearances outweighs all these disabilities, is its power of establishing itself in the dense shade of these high-level forests, and their dense undergrowth. It is clear then that the silver fir must suffer in many ways from the hand of man and will tend to disappear where occurring in small isolated areas in forests where the pressure of the population is considerable; protection, on the contrary, should result in the more complete occupation of areas in which it is already established, and its gradual encroachment on the adjoining oak areas—an extension which the forester will ordinarily encourage and assist as far as possible. Where silver fir has been exterminated, it is not unusual for the deciduous forest of bird cherry, maples, etc., to retain possession of the ground in open park-like formation.

Summary.—From what has been written above, it would appear that the effect of the population and their cattle on these Kumaon forests has been :—

(i) The total destruction of the forests for agricultural purposes in all the valley bottoms and much of the hill slopes, chiefly in the *chir* zone and, lower down, in the sal.

(ii) The destruction of the forests over considerable areas of hillsides adjoining the cultivation, in *chir* and *banj* zones, by prevention of regeneration through burning, browsing and lopping, together with gradual removal of the overcrop. The result is usually bare, very inferior grass land.

(iii) The denudation of hillsides, mainly in the upper *banj* and *moru* zones through the practice of shifting cultivation, such areas supporting a fairly dense low shrub cover between periods of cultivation.

(iv) The creation for cattle stations or periodic cultivation, in all zones, but especially the upper ones, of clearing themselves tending to become centres of further destruction.

(v) The favouring of sal in sal areas over low-level miscellaneous, by the earlier destruction of the latter where the pressure is great, but the restriction of sal by deterioration of the quality of the locality.

(vi) The extension of *chir* upwards into the oak, and that of low level miscellaneous upwards into the *chir*.

(vii) The extension of *banj* into the *moru* but its withdrawal before the *chir*.

(viii) The restriction of the *moru* in favour of the *banj* and *kharsu*.

(ix) The restriction of silver fir in favour of *moru* and *kharsu*.

Of these (i) to (iv) are direct result and self-obvious, (v) to (ix) are less direct and may be summarised by saying that the hand of man is a withering hand, a powerful dessicator, in that it shifts the balances from the more mesophytic to the more xerophytic type of vegetation. The first result in the list is inevitable, and in fact desirable: it is the task of the forester to do all in his power to reverse the other eight, and initiate a back swing to the pendulum towards the higher type.

H. G. CHAMPION, I.F.S.

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FOREST SETTLEMENTS AND VILLAGES IN THE SATPURA HILLS OF THE EAST KHANDESH DIVISION, BOMBAY.

Having read the article in the November number of the *Indian Forester* on "Forest Villages in Assam," it has struck me that it may be of interest to readers to hear of somewhat similar villages in and along the foot of the Satpura hills in East Khandesh.

A short description of these hills will give the reader a rough idea of the lie of the land, and he will then understand more readily the distinction between the two kinds of villages that give us help. These hills then are really an extension of the Satpura hills of the Central Provinces, and form the scarp where the plateau of Holkar State drops down about 1,500 feet to the

broad fertile plains of Khandesh in the Tapti valley. Our forest territory is bounded on the south by the edge of the cultivated land of East Khandesh, and on the north by the Aner river, which runs parallel to the Tapti, and divides our part of the hills from the forests of the Holkar State. Our forest in these hills then is a strip running from east to west along nearly the whole of the northern boundary of East Khandesh; the length of this strip is about 65 miles, and the breadth 8 to 16 miles. The scarp is much broken by nalas and ravines running down towards the Tapti, and, similarly, the northern face of the watershed, by nalas running into the Aner river. It is as a rule only in these nalas that we find timber of any value. The rest of the jungle consists of a very open straggling growth, mainly of *Boswellia serrata* at the top, and *Hardwickia binata* on the lower slopes of the hills. The grass is long and abundant, and the forest suffers much from grass fires, which though they do little harm to the mature trees, effectively kill off the little regeneration that is already hard put to survive the long dry hot weather.

In these forests, the only departmental works we do are very light improvement fellings in some of the coupes after the contractors have worked their wicked will on them, and very light road repairs; the latter merely comprise clearing off the boulders which have got carried on to the roads by the rains. The only works that we require to be done are these fellings, these road repairs, our fire-tracing, and fire extinguishing work; we therefore do not need nearly as extensive a system of forest villages as that of the Assam forests seems to be. Our system then being very simple, in many ways not giving as good results as might be desired, and in fact being nothing very much to "write home about," I trust I may be pardoned if I appear to digress unduly on the people themselves—to my mind, at any rate, quite as interesting a subject.

The villages with which we have to deal, may be divided into two classes:—

(*a*) The Forest Villages proper.

(*b*) Our own Forest Settlements, established by us, and entirely under our control.

A.—*Forest Villages proper* are those villages which at the time of the forest settlement, contributed land to forest; their inhabitants are ordinary 'ryots,' cultivating Revenue land along the foot of the hills. They have however a long list of privileges, detailed in the North Tapti Privilege Code, which are dependant on their continuing to help the Forest Department in fire-protection and in other ways. As these privileges consist of grass, earth, stone, and other kinds of minor produce free, and grazing, bamboos, firewood, and even sometimes timber, on permit, they are of enormous value to the people; consequently the D.F.O. is to them in many ways as much a person to be reckoned with as the Revenue Officers proper. They are bound to turn out free of charge to assist in extinguishing fires, and to give labour on payment for cutting and burning fire-traces; so many miles of fire-line are allotted to each village and payment is made in a lump sum to the *patel* or *panchayat*, and varies from Rs. 5 to Rs. 12 per mile of fire-line. If the people refuse, or fail to give the help required of them, they are punished by suspension of their privileges and by increasing their grazing fees; if they do their work uncommonly well and willingly, they are sometimes rewarded by total remission of their grazing fees. This is, after all, fair, as it may be said that part of the payment required from them for their privileges is taken out in kind, and therefore, failure to help comes to the same thing as failure to pay for goods received. Government recommends that a system of "individual responsibility" be adopted for these rewards and punishments; this means keeping lists of those individuals who did, or did not, help, but in the majority of cases the villages are practically unanimous in helping or in not helping, so that we have to fall back on the system of "communal responsibility," *i.e.*, rewarding or punishing the whole village collectively.

On the whole these villages are of great value to the forests, but the system has some serious disadvantages:—

(*a*) The privileges received by the villagers were originally granted on far too liberal a scale, and the consequence is that in respect of payment in kind, at any rate, they receive far too much value for what at most consists of 15 days' work per year

for a small proportion of the population of the villages, and is after all for their own ultimate advantage.

(*b*) A result of this wholesale grant of privileges is that the jungle is always full of privilege-holders, and this is of course a very fruitful source of fires in the fire-season. It also makes it practically impossible to trace fire-offenders, as, for minor privileges at any rate, it is impracticable to insist that free permits shall be taken every time the privilege-holder goes into the forest.

(*c*) Whether the system of communal responsibility or that of individual responsibility be adopted, local subordinates have practically unlimited opportunity for oppression, as it is of course on them that the D. F. O. must as a rule depend for reports on which villages have or have not helped.

On the other hand, the system has one great advantage—that the Forest Department can obtain its labour for fire-tracing work with little difficulty at a low fixed rate, and at a time when labour is most difficult to get, *i.e.*, in the end of the cold weather, all through the harvest of the 'rabbi" crops.

B.—*Forest Settlements.*—Fourteen of these settlements have been established in the more inaccessible parts of the hills, so spaced out as to distribute the population as evenly as possible over the area. They have been populated by the Forest Department, almost entirely with Bhils and Tadwes. We give them a village site, and each man a plot of about ten acres; they have to clear their plots and the village site themselves except for reserved trees, and as a rule, unless it is particularly valuable, they are given what they cut for building their houses. When necessary, they are given "tagai" loans before the rains for cultivation expenses; these loans they have to pay back after harvesting their crops. Also they have all the privileges of a forest village proper, with the additional, and not inconsiderable, privilege of free grazing.

In return they are bound :—

(*a*) to pay us land assessment at the rate of Re. 1 per plot per year—little enough, considering that the land is usually very good,

(*b*) to live in the settlement all the year round, having to obtain the Ranger's permission to leave the settlement for more than one week, and the *patel's* (headman's) permission for lesser periods,

(*c*) to assist in the detection of forest offences—in actual practice they are themselves as frequent offenders as anyone else,

(*d*) to assist in extinguishing fires,

(*e*) to provide on payment, such labour as the D. F. O. may demand for forest works.

For breaking any of these rules, they are liable to expulsion from the settlement, and confiscation of their crops and such other property as they have received free from the Forest Department. The paid labour we take from them consists of fire-tracing, 'kutcha' repair of roads, improvement fellings, and casual work in connection with the D. F. O.'s camp. We pay them for fire-tracing and roads on exactly the same principle as that by which we pay the forest villagers for fire-tracing.

The Forest Settlement system is on the whole advantageous to the department because :—

(*a*) It ensures a limited supply of labour in the wildest and most inaccessible parts of the hills, where nevertheless, fire-tracing work is most important.

(*b*) It is on these people that we depend to check the great fires that sweep over from the Holkar boundary every year, sometimes on as much as a ten mile front. Being right on the spot, they are sometimes able to prevent these fires from crossing our northern boundary, and even if they fail in that, they are usually able to prevent them from spreading very far.

(*c*) They are able to get quickly to any fire started by bamboo or grass-cutters in these inaccessible parts of the jungle, and thus to extinguish in its infancy what would inevitably develop into an extensive fire, if we were solely dependant on the people of the forest villages at the foot of the hills.

(*d*) They are an easily available source of labour for odd jobs connected with the maintenance and moving of the D. F. O.'s camp when he is touring in these areas; it would be very inconvenient if he had to get such labour from villages on the plains, which are often as much as 15 miles away. On the other hand, the system has some disadvantages, these being largely due to the characteristics of the Bhil and Tadwe castes. These characteristics will be easily understood from a short history of these castes.

The Bhil, in olden days, used to live only in wild inaccessible jungles like these; indeed, in those days, most of the Khandesh plains consisted of jungle. He obtained his livelihood almost entirely from the forests, which provided amply for his simple wants. It gave him game, fruits, roots, honey, etc., to eat, wood to burn, and grazing for his few beasts. As he was a man of plenty of personal courage, he used to make frequent raids on his more peace-loving brethren of the cultivated lands, in order to acquire those commodities which the forest did not provide.

With the coming of the British rule, however, he soon found his activities cramped to a large extent, and came to realise that these raids caused more subsequent trouble than they were really worth. Then came Forest Conservancy and the Game Laws, and he found that, what he had always regarded as his natural rights, *i.e.*, shikar, and as much as he wanted of the produce of the forests were forbidden him, more and more, as time went on.

The consequence of his early happy care-free life, in which he obtained all his wants with a minimum of trouble, is that he has never acquired an aptitude or taste for cultivation, and finds himself now, rather a pitiful anachronism in a hard and unsympathetic world, where his daily sustenance is not to be had for the gathering, to nearly the same extent as it used to be. True, large numbers of Bhils were brought down to the plains by the formation of the Bhil Corps, and on the disbandment of that corps, remained on the plains as police, agricultural labourers, and even as independant cultivators. It is not however with these

that we have to deal, but with the present-day "jungly" Bhil who has stuck to his old jungle life.

He is a simple, comparatively guileless soul, whose most noticeable characteristics are a rooted objection to most kinds of work, a marked weakness for "Wein, Weib, and Gesang," and a bland disregard for the rules of the Forest Department. On the other hand, he is a very lovable follow—his weaknesses are after all very human—and once one has gained his confidence and respect, he is ready to do a surprising lot for one. As a shikari he is hard to beat, and having an intimate knowledge of the jungles and of the habits of the game, seems to have an almost uncanny knack of knowing where the latter is to be found. He does quite a lot of shikar (illicitly) on his own account, and so is in full sympathy with a D. F. O. whose tastes lie that way I would rather have him as a beater or shikari for dangerous game than anyone else, as apart from his knowledge of the country and animals, he is possessed of a high order of personal courage, and will as a rule not let one down in a tight corner. He is superstitious to a degree, but as rule, unless one is very much in his confidence, will not tell one much about his omens, etc., for fear of being laughed at. He is fond of performing some kind of "pooja" on one's rifle, and curiously enough, I shot a tigress the day after the only occasion on which I allowed this to be done. I may add that the cost of the ceremony is one fowl, one cocoa-nut, and one bottle of "daru" or liquor. He is extremely fond of this latter—indeed firmly believes that without its regular and sufficient consumption, his health suffers; he himself would probably emphatically deny the possibility of sufficient consumption. His tastes in love are rather promiscuous, but that is after all entirely his own affair. He will turn out in force to do his tribal dance for you for the small consideration of a ration of "daru" per man—the larger the ration, the better the dance. This represents various scenes of shikar, recent actual happenings and, other things, all carried out in a queer sort of shuffling rhythm, and what is lacking in technique is more than made up in enthusiasm. He has a hearty, though perhaps rather crude, sense of humour, such subjects as a man falling from the top of

a high tree, or mistaking a monkey for a tiger, provoking him to shouts of merriment.

The Tadwe caste was formed many years ago by the inter-marriage of Bhils and Mahommedans, the latter religion being retained as the religion of the caste. The results to-day is a caste which shows few of the good and most of the bad qualities of both component castes. The Tadwe is however a better cultivator than the Bhil, and I have met examples who were quite good fellows. On the whole, though, their tastes lie in the direction of fraud, theft, and dacoity, and they do not stop short of murder itself. They are the worst forest offenders we have, and on detection by forest guards, think nothing of threatening and even beating the latter, so that I am afraid it is more than probable that the worst characters are seldom, if ever, brought to book.

It will now be readily understood that our settlers are much given to helping themselves freely to forest produce of all kinds; they are apt to obtain grants of "tagai" from a soft-hearted D. F. O. by harrowing his soul with pitiful tales of destitution, to spend the grant on "daru," to make no attempt to cultivate their plots and then to say, of course with perfect truth, that they cannot pay back the grant; they are apt to stop in the settlement just as long as it pleases themselves, and then, usually in the fire-season, when they are most necessary to us, to disappear altogether for months at a time. On the other hand, such is the reputation of the climate and the terrors of these jungles, among the people of the plains, that the Bhils and Tadwes are about the only people who will agree to live there at all, so we have to be content to take what we can get; considering everything, I think myself that we might do a lot worse.

Such then is the material with which we have to work, and the surprising thing is that we do, as a general rule, get them to cultivate their plots; we do get them to stay in their settlements during the fire-season—some of them at any rate; we do get back the bulk of the "tagai—it is like trying to wring blood from a stone; and finally, we hope, that we do gain to some small extent their confidence and respect, on which after all, all the rest depends.

J. L. BELL, I.F.S.

A FRENCH REVIEW OF GAMBLE'S MANUAL OF INDIAN TIMBERS, 3RD EDITION.

The following review, taken from the October number of the " Revue des Eaux et Forêts," may be of interest.

Mr. J. S. Gamble, after having been through the course at the Forestry School at Nancy, served in the Forest Service in British India, from 1871 to 1899, and is the author of an excellent work on Indian Timbers. This work has already been through two editions, the first in 1881 and the second in 1902.

The third edition which has just come out, differs especially from the first edition, in that it has two appendices, which refer firstly to the trees, of which the author has received timber-specimens, since 1902, and secondly to those trees, whose timber-specimens were sent to him from Assam in 1921 ; a map in colours of the Indian Empire is also added, in which is included Baluchistan, Burma, the Laccadive Islands, the Maldive Islands, Ceylon, the Andaman and the Nicobar Islands.

For the rest, the arrangement of the third edition is identical with that of the second edition ; the text has only been corrected in a few matters of detail ; the photographic illustrations remain the same.

Mr. Gamble, who took an interest in questions of forest technology, since the time when he was at the Nancy School where he was the pupil of Mathieu, informs us of the circumstances under which the first edition of his work was published, as the result of the preparation by the Government of India, of a collection, which was sent to the Universal Exhibition of 1878 in Paris.

The author explains how the wood specimens were collected, of which, one collection was sent to the Forest School at Dehra Dun ; how the descriptions were made, to start with, by a commission constituted for this purpose, afterwards by himself, he mentions the works which had been published on the subject before his work appeared, and he indicates which works were the most useful to him, among these he quotes the Flora of British India by Hooker, the Flora of India by Roxburgh, the

Forest Flora of North-Eastern and Central India by Brandis, the Forest Flora of British Burma by Kurz, the Flora of Ceylon by Trimen and Hooker.

Mr. Gamble informs us how the vernacular names were gathered together, in truth, seeing the difficulty and the complexity of the question, he is not able to guarantee the entire correctness of these names; but nevetheless, he thought it was necessary to give these names, because they can be of great assistance in the scientific determination of the species in the different provinces of India.

The author then gives some details about the different forest regions of India; in the text of the work, each of these, with the exception of Ceylon, is designated by a capital letter, which placed in front of the serial number, of the wood specimen studied, shows the region from which that particular specimen came.

The author, has asked himself, whether it would not be advisable to publish a general key for the determination of Indian woods; but he did not consider it advisable to do so, apart from the fact, that a key of such a general character, would be very difficult to establish, he thinks, that, particularly, its use, in any particular area would be very inconvenient considering the great multiplicity of the species dealt with in comparison with the more or less reduced number of those actually represented in the area; he also shows his preference for purely regional keys; and to quote examples, he indicates the bases, on which were established the keys of Nordlinger, Mathieu, Mashall-Ward, and that of Brandis, as an addition, to the second edition of his Forest Flora of North-Eastern and Central India.

Mr. Gamble informs us of the arrangement which he has adopted, to facilitate the study of each species, and the different authorities which he has referred to, in his work.

He gives some details about the tables and the index, which he has thought fit to place at the end of his work, in order to facilitate their use.

For a region as vast as India, a region which extends between 6° and 36° of latitude and through nearly 40 degrees of longitude, the author evidently could not describe all the existing forest species, whose number is about 5,000, and even much more, according to Hooker. He has retained about 1,450 species in the second edition, and nearly 1,550 in the third edition.

He considers that all the genera, and all the important woods have been studied by him.

In the text of the work, the species are classified, methodically, by division, class, series, order, tribe, genus, and sub-genus.

For each of the large divisions, the author gives, in a very concise manner, the most important pieces of information, notably with reference to the distinctive characters.

For each genus, he sets forth, clearly and concisely, the number of species, the principal characters, the division into sub-genera, if there is occasion for this, and for the more important, the description of the woods.

Finally, for each species, Mr. Gamble indicates the Latin synonyms, with the names of their authors, the vernacular names in the different regions, the geographical distributions, the habitat and the locality, the characteristic features of the bark and of the wood, the growth of the tree, the useful products which it supplies; in the case of the chief species he dilates on the characters of the wood, gives also the weights of the different specimens which have been studied, and the co-efficients of strength.

The descriptions of the species are generally short; they only occupy more than one page of the text, when it is a question of particularly important trees, such as, for example, *Shorea robusta* which Indians call sal, *Swietenia Mahagoni*, *Cedrela Toona*, *Chloroxylon Swietenia*, *Mangifera indica*, *Dalbergia Sissoo* and *Dalbergia latifolia*, *Pterocarpus dalbergioides* and *Pterocarpus santalinus*, *Xylia dolabriformis*, *Acacia arabica* and *Acacia Catechu*, *Terminalia Chebula* and *Terminalia tomentosa*, *Tectona grandis*, which the English call teak, *Santalum album*,

Ficus bengalensis and *Ficus elastica*, *Quercus semecarpifolia* and *Quercus incana*, *Juniperus macropoda*, *Pinus excelsa* and *Pinus longifolia*, *Cedrus Libani* var. Deodara, *Picea Morinda*, *Abies Pindrow*, *Borassus flabellifer*, *Cocos nucifera*.

The work is illustrated with 100 good photographic reproductions, of which four represent forests or interesting trees, and the remaining 96 are wood sections of the more important species.

Four tables or indices make references, both easy and rapid; they give, firstly the European names, secondly the Latin scientific names, thirdly the vernacular names, and fourthly the numbers of the specimens studied; each number being preceded by the capital letter, which indicates from which region of India this specimen came.

The book is published with care, in type of different sizes, according to the importance of the subject. The publishers have tried to give abundant matter in a portable volume and they have succeeded.

This work of Mr. J. S. Gamble does not compete with that of Mr. R. S. Troup, which I have recently dealt with, in this Review, but completes it; the Silviculture of Indian Trees, by Mr. Troup, is, above everything else, a work of silviculture and botany; the Manual of Indian Timbers by Mr. Gamble, is especially, a treatise of forest technology.

Mr. Gamble's book can be consulted with the greatest interest and the greatest profit by all foresters, notably by those who are in service, in British India, and the neighbouring countries.

It is included among those indispensable works, which all those people who use timbers from India or contiguous countries, ought to possess, and even, all those who are simply interested in these exotic woods.

L. PARDE.

REPORT ON TANNIN CONTENT AND TANNING PROPERTIES OF CERTAIN SPECIES OF LAGERSTRŒMIA IN BURMA.

BY J. A PILGRIM,

Tannin Expert to the Govt. of India,

AND

E. PASUPATI.

The Forest Economist at the Forest Research Institute and College, Dehra Dun, has recently received a detailed report by Mr. J. A. Pilgrim, Tannin Expert to the Government of India, on investigations into the tannin content and tanning properties of certain species of *Lagerstrœmia* found in Burma. The work of analysis was carried out by Mr. E. Pasupati, Senior Assistant to the Tannin Expert, mainly during the absence of Mr. Pilgrim on leave, while the small scale tanning tests, and compilation of the report were done in collaboration with Mr. Pilgrim after the latter's return from leave. Mr. Pilgrim, however, is responsible for the deductions drawn and for the general observations contained in the report.

2. The investigation was undertaken, because Mr. Pilgrim had previously found, that one variety of *Lagerstrœmia*, namely *L. parviflora*, growing in North Bengal was capable of yielding 10 per cent. of an extract containing about 50 per cent. of tannin. This tannin possessed many of the characteristics of chestnut tannins and also produced a leather practically identical in colour with that produced by chestnuts found in Northern Bengal.

3. In the case of the Burma *Lagerstrœmias*, samples of the leaves, fruit, twig bark, twig wood, bole, bark, and wood of four species were tested, namely :—

Lagerstrœmia villosa.

L. Flos Reginæ.

L. macrocarpa.

L. tomentosa.

The samples were collected from trees in the South Toungoo Forest Division.

A special note of caution is necessary with regard to the names of these species, for in some cases there is more than one variety of them and as will be seen from the table below, the analyses for different specimens of the same botanical species, collected at different places, show different percentages of tannin content. For example the results of analysis of the fruit of *L. Flos Reginæ* shows three different results. The specimens were collected at different places, and are recognised under separate names by the local inhabitants, although botanically they are the same. Further, Burmese names for the same tree vary from place to place, and for this reason, the results of analysis have been classified under the botanical names rather than by the local Burmese equivalents.

Firms or individuals who are interested in the manufacture of tannin extracts as a commercial proposition are therefore strongly advised to take expert advice, before embarking on any scheme for the manufacture of tannin extract from Burma *Lagerstrœmias.*

4. A number of the parts of the four species of trees mentioned above, were rejected as unsuitable for the manufacture of tannin, or for use in tanning, on the evidence of preliminary tests. Others were rejected as useless after analysis, and the table below gives only the results of the investigation of those particular parts of each tree which give useful results, and which are consequently suggested as suitable for employment in the manufacture of tannin extract.

Some of the rejected components may still be found, if collected under different conditions as to season, to give results justifying their inclusion in the list, but this must await further investigation.

5. Ordinarily this report would have been published in the form of a Forest Record, but from the point of view of the manufacturer the information is not yet complete, in so far that no survey has yet been made as to the localities in which these

species of *Lagerstrœmia* occur in Burma, or as to the amount of raw material available.

The Chief Conservator of Forests, Burma, regrets that it is impossible at the present moment to spare an officer to undertake such a survey, and in order that the information so far as it has been collected may be made available to the public without delay, it has been decided to issue this preliminary announcement. It is known that these *Lagerstrœmias* occur in comparatively large quantities in many parts of Burma, and local officers of the Forest Department will be instructed to give all the information at their disposal to any *bonâ fide* enquirer. The detailed report is for the present kept pending with the Forest Economist at Dehra Dun, and a copy of it can be made available on loan to any person who satisfies the Economist as to his intentions.

Summary of Results in Relation

Tanning Materials.	Percentage of tannin of DRY.	Percentage of soluble non-tannins on DRY.	Yield of solid block extract with 15% moisture from air, dry raw material computed at 10% moisture.	Theoretical maximum possible percentage of tannin in Solid Block extract with 15% moisture.	Yield of CRYSTALS with 5% moisture from air dry raw material computed at 10% moisture.
Lagerstrœmia villosa.—					
(1) Leaves	20·23	14·17	36·42	49·99	32·49
(2) Bole bark ...	6·36	3·84	10·08	53·00	9·66
(3) Bole wood ...	3·76	2·73	...	...	6·15
L. Flos Reginæ.—					
(*a*) Leaves	13·30	8·23	22·80	52·51	20·40
(*b*) ,, ...	12·83	9·27	22·34	49·35	20·94
(*a*) Fruit	14·26	9·12	24·76	51·84	22·15
(*b*) ,, ...	14·71	8·80	24·89	53·18	24·27
(*c*) ,, ...	17·28	8·64	27·44	56·67	24·56
Lagerstrœmia macrocarpa.—					
Young red leaves ...	35·50	1220	50·51	63·26	45·19
(*a*) Mature leaves ...	13·79	873	23·84	52·05	21·33
(*b*) ,, ,, ...	14·86	964	25·94	51·56	23·21
(*a*) Bole bark ...	8·84	490	14·55	54·69	13·02
(*b*) ,, ,, ...	6·36	3·84	12·77	53·78	11·43
(*a*) Fruit	16·60	9·27	27·39	54·54	24·51
*(*b*) ,, ...	15·09	13·10	29·85	45·50	26·71
Lagerstrœmia tomentosa.—					
Leaves	15·13	10·11	26·72	50·95	23·91

*Suitable for direct application only.

to Tanning Properties.

Theoretical maximum possible %age of tannin in CRYSTALS, with 5 per cent. moisture.	Small scale tanning test yield of dry leather calculated on the wet (drained) weight of delimed pelt.	Description of Tannage.	Colour of chromed hide powder in the analysis.	Tintometer colour measurement of a filtered infusion containing 0.5 per cent. of the tannin.		
				Red.	Yellow.	Black.
55·87	No test	....	Pale yellowish buff	4	9·6	*Nil.*
59·24	63·45	Slightly violet tinged buff. Penetration slow.	Pale, violet shade of pink.	11	25·2	,,
55·04	No test	....	Pale, somewhat reddish buff.	13·5	44·5	,,
58·68	57·60%	Strong supple light buff leather.	Pale, greenish yellow buff.	6·6	24·2	,,
55·15	52·0%			8·5	31·7	,,
57·94	69·29%	Pale buff ...	Brown ...	22·2	61·9	,,
59·44	64·62%	Pale buff slightly paler than (*a*), both firm strong leathers.	,, ...	10·8	34·2	,,
63·33	No test	....	Light yellowish brown buff.	11·8	37·3	,,
70·70	No test	....	A slightly reddish brown shade of buff.	6·6	22·2	,,
58·17	,,	....	Light buff ...	9·8	42·3	,,
57·62	,,	....	,, ...	8·5	32·1	,,
61·12	61·29 %	Penetration slow, leather very tough, colour, a slight reddish brown.	Pale dull red ...	19·0	38·5	,,
60·10	No test	....	Orange brown ...	26·8	95·3	,,
60·96	62·9 %	Dull buff ...	Slightly greenish brown buff.	17·6	56·9	,,
50·85	57·0 %	Dull buff grain, more drawn than (*a*).	Orange brown ...	22·5	15·0	3
56·95	No test	....	Light brown buff...	5·6	23·7	*Nil.*

NOTE.—The above figures of yield of leather calculated on the drained "wet weight" should be regarded primarily in a relative rather than an absolute sense, bigger scale tannages as a rule giving different and generally lower figures.

NOTE BY THE RAILWAY DEPARTMENT (RAILWAY BOARD) ON RAILWAY SLEEPERS IN INDIA.

Some very inaccurate and misleading statements have recently appeared in the public press as to the extent of purchases by Indian railways of wooden sleepers from Canada, and other sources outside India. The Railway Board consider, that it is desirable that these should be contradicted, as they may affect the industry in India to a considerable degree.

During the past 10 years from 30 to 40 lakhs of wooden sleepers have been purchased annually by Indian railways, and during the next 5 years it is estimated that 40 to 50 lakhs will be required annually. During the last two years 8 lakhs have been imported from outside India or 4 lakhs each year, including 3½ lakhs from Australia, 2½ from the United States of America and 2 from Canada.

The bulk of the wooden sleepers used on Indian railways are deodar, sal and *pyingado*, and sleepers of these timbers are as goord in quality, as any imported wooden sleepers and certainly superior to the creosoted pine sleepers from America. Sleepers are only imported from outside India to make good the shortage of supplies in India.

Steel and cast iron sleepers are used fairly extensively and are manufactured in India. A satisfactory concrete sleeper is also now being manufactured in India, and efforts are being made to introduce treated sleepers of inferior Indian timbers. All of the above sleepers are Indian products and are now on the market in healthy competition. The choice of one or the other for use on any particular railway, depends on many factors including life in the track, price, distance from source of supply and climates. Steel and concrete sleepers have only recently been manufactured in India, and supplies of this class of sleeper should supplement supplies to the exclusion of imported sleepers from America and elsewhere.

It may be noted, that arrangements for the supply of sleepers are dealt with by the Railways and not by the Railway Board.

A NOTE ON THE DURABILITY OF INDIAN TEAK.

BY S. M. EDWARDES, C.S.I., C.V.O.

The antiquity of the Indian export trade in teak (*Tectona grandis*) is proved by various references to it in the works of ancient writers. The earliest of these is Ptolemy, the author of "Periplus" (*circa*, A.D. 80), who speaks of "great vessels with brass, and timbers and beams of teak," being despatched regularly from Barygaza (the modern Broach in Western India) to the ports of the Persian Gulf. The word "teak," it may be noted, is merely a European corruption of the Tamil word *tekku* and was probably adopted owing to the fact that Europeans first became acquainted with the wood in Malabar, which was exporting this timber to Babylon three centuries before the Christian era, and is still in our own day one of the two great sources of supply. The trade appears to have continued throughout the centuries, unchecked by the political vicissitudes of India; for Al-Masudi records the export in the middle of the tenth century of enormous teak logs to the depôts of Basra, Iraq and Egypt. The Portuguese, after the establishment of their empire in the East, were not slow to perceive the value of this timber as an article of export. Several of their historians make reference to it; for example, P. Francesco de Sousa, who speaks in his *Oriente Conquistado* of "*teca* (teak) which is a wood not subject to decay": while in 1597, we find the King of Portugal enjoining the Government of Goa "not to allow the Turks to export any timber (*i.e.*, teak) from the Kingdom of Pegu."

As regards the durability of teak, we have in the first place the evidence of Dr. Sayce, the famous Assyriologist, that Indian teak was discovered in the ruins of Ur of the Chaldees, thus proving that commerce by sea between India and Babylon was carried on about 3000 B.C., when Ur Bagas, the first King of united Babylonia, ruled in Ur. Again, exploration has discovered fine beams of teak, still *undecayed*, in the walls of the great palace of the Sassanid Kings at Seleucia or Ctesiphon, which dates from the middle of the sixth century. Even more remarkable

are the teak ribs which to this day ornament the roof of the great *chaitya* or Buddhist chapel, excavated from the solid rock, at Karli in the Poona district of the Bombay Presidency. This great cave has been described by Fergusson in his *History of Eastern and Indian Architecture* as the largest and most complete Buddhist chapel hitherto discovered in India, and he gives good reason for believing that, together with the monks' cells surrounding it, it was excavated not very long after stone first came into use as a building material in India. From other evidence, and from the researches of archæologists, we know that the general use of stone in northern India for building, sculpture and decoration, dates from the reign of the Mauryan Emperor Asoka (273—232 B.C.), and experts are agreed that these caves at Karli near Poona were probably hewn out of the living rock about the year 80 B.C., and that the great teak ribs which ornament the semicircular roof *are coeval with the excavation.* The writer of this note twice visited these caves during his years of service in India, once in 1903, and again in 1911; and he can testify to the fact that the ribs of teak, which overhang the *dagoba* or relic-shrine of the Buddha, are as perfect as on the day, two thousand years ago, when the pious excavator of the caves gazed upon his finished work and found it good. As one stands before the sculptured pillars of the shrine and tries to recall all that has happened in India during that long period, the longevity of these teak timbers strikes the imagination with redoubled force. Great empires, like that of the Guptas, of Vijayanagar, of the Moguls and the Marathas, have risen and decayed: even the religion, in honour of which the beams were originally hewn and set in their places in this rock monastery, vanished from India as a living creed many centuries ago. But the timbers have defied the ravages of time, and stand immutable as the great hill-ranges which dominate western India.

The history of ship-building in India offers further proof, if it be needed, of the extraordinary durability of teak. The first master-builder of the Bombay Government Dockyard was a Parsi, Lavji Nasarvanji Wadia, who commenced building ships of teak in 1735 and, on his death in 1774, handed

down his knowledge and reputation to his grandsons. They and their descendants served the East India Company as shipbuilders until 1837, and during this period of a little over a century they constructed 170 war vessels and other craft for the Company, 34 warships for the Royal Navy, 87 merchant vessels for private firms, and three ships for the Imam of Muscat. These ships were all built of teak, and many of them lasted for fifty or sixty years, as, for example the *Bombay*, built for the Bombay Marine in 1739, and described as "a staunch and stout vessel" in 1800. The brig *Euphrates*, built in 1828, was perfectly sound in the hull in 1900; while H.M.S. *Meeanee*, built at Bombay in 1844, and serving in 1905 as a hospital ship in Hong-Kong harbour, was reported at the latter date absolutely sound. Lieut.-Colonel A. Walker, author of *Considerations on the Affairs of India*, wrote in 1811: "It is calculated that every ship in the Navy of Great Britain is renewed every twelve years. It is well-known that teak-wood built ships last fifty years and upwards"; and barely ten years earlier Rear-Admiral Sir T. Troubridge had written to Framji Wadia, who held the post of master builder at that date (1802), "I have pledged myself you will produce ships that will eclipse those built in England." The Admiral's statement was put to the test, and proved to be perfectly true. Many teak-wood ships, built in the Bombay dockyard, were purchased for the British Navy after they had been running fourteen or fifteen years, and were found to be perfectly strong and seaworthy. The *Sir Edward Hughes* performed eight voyages as an Indiaman before she was acquired by the Royal Navy; whereas no Indiaman built in Europe was capable of completing more than six voyages with safety.

One of the most remarkable of these teak-built ships was the *Swallow*, which the Wadias launched in 1777. She commenced her career as a Company's packet-boat, making several trips to England. She then joined the Bombay Marine, but reverted shortly afterwards to the packet service. In 1800 she was sold to the Danes, and sailed to the West Indies, where she was seized by a British man-of-war for breach of treaty and condemned as prize. She was next purchased by the Admiralty

and served for several years as a war sloop, and finally, having again become a merchant vessel, she ran out to India and was lost on the James and Mary shoal in the Hooghly in 1823. Among the finest battleships built of Indian teak and launched from the Bombay dockyard, was the *Ganges*, which afterwards served as the flagship of Sir Edward Codrington at the battle of Navarino. The last ship built by the Wadias was the *Investigator*, which was still in commission in 1909 as the head vessel of the Indian Marine Survey. Surely the English traveller, Dr. Fryer (1675), was justified in calling the teak tree "this Prince of the Indian forest." Its qualities were certainly an important factor in the gradual rise of British naval power in the East.—[*Empire Forestry*, *Vol. I*, *No. 2*.]

ANTISEPTIC TREATMENT OF SLEEPERS.

POWELLISING METHOD—DEEPER PENETRATION POSSIBLE.

India, for the past ten or eleven years, has been experimenting with a view of testing the durability of railway sleepers which have been preserved by various methods of antiseptic treatment. The results of tests made have now been co-ordinated and published in the form of a report by the Ecenomist at the Forest Research Institute, Dehra Dun, and this report makes very interesting reading for those engaged in forestry and the timber trade. One of the methods of treatment experimented with in India was the powellising process commonly employed with karri in Western Australia, and the Indian trials go to show that the process gives most satisfactory results there. Under this method the timber is boiled in a solution of arsenic and molasses, and afterwards subjected to a drying process at high temperatures, by which means it appears that the fibre is stabilized and the solution taken up in combination with the inherent sap in the fibre, while the free sap is driven out by the heat. Satisfactory as the treatment has been found here, it seems, from the Indian experiments, that it is capable of an improvement which will make for greater efficiency; that is in the mode of introducing the anti-

septic into the timber. In Western Australia the practice is to place the sleepers in large tanks filled with the antiseptic solution and soak them at a high temperature until impregnated, whereas, in India, it has been found preferable to force the solution into the timber in pressure cylinders. As the Economist, Mr. R. S. Pearson, says, " In the case of powellising, there appears no reason to adhere to the old method of introducing the antiseptic in open tanks, as by doing so in pressure cylinders, will result in deeper penetration." This fact may prove of great importance to those in Western Australia engaged in the preservation of timber. The deeper the impregnation, the more likely is the timber to withstand the ravages of insect and fungoid pests, and the danger of dry rot, although all experiments and tests with karri powellised in open tanks show it to be so thoroughly impregnated that it is difficult to see how any such alterations can be warranted.

Karri, known in Western Australia as the "queen of superstructural timbers," is possessed of extraordinary strength and hardness, and is eminently suitable for all purposes above ground. It has, however, one weakness, and that is it is not durable in the ground. To remedy this defect all karri for use as sleepers and other underground work must be subjected to a preservative treatment, and powellising is the method used with great success here. The timber, after powellising, becomes immune to the attacks of borers and to the disease of dry rot. It has not been possible up to the present to observe the actual life of powellised karri sleepers, as none have been in the ground long enough to establish this fact, although those in use to-day have given excellent results so far. Nearly half a million powellised karri sleepers were used in the Trans-Australian Railway, principally at the Western end, and have given every satisfaction, a remarkably small number having had to be removed. In the Northern Territory railway, opened for traffic in December, 1917, there were used some 94,000 powellised karri and 10,000 powellised jarrah sleepers. None of the jarrah sleepers have had to be replaced, and only nine of the karri sleepers.

Other and numerous examples might be quoted of the efficiency of the powellising process, but suffice it to say that the

method has proved most satisfactory in Western Australia up to date. This fact, however, gives no justification for neglecting further experiments which might add to the efficacy of the treatment.—[*The Australian Forestry Journal.*]

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A VISIT TO MYITMAKA TRAINING WORKS BURMA, SEPTEMBER 1922.

INTRODUCTION.

Having recently been enabled to pay a short visit to the Myitmaka River under the Divisional Forest Officer, Mr. Cheyne's guidance, it is thought that a brief popular description of what is now being done might be of general interest, it would be presumption for a layman to attempt anything in the nature of a detailed report after only three days' visit, neither have expressions of opinion on matters of controversy been attempted, all that is intended being a brief outline of past conditions and an account of things as they are. Reference is invited to an article on the same subject by the late E. V. Ellis in the January number of the *Indian Forester* for 1912. To understand the problem that has had to be faced, some brief description of the general conditions is necessary. The Myitmaka or Hlaing river runs through a belt of low-lying scrub jungle, stretching from the

1. The lower end of a new cut to extend the stream through the "thegaw". Photo taken at beginning of the rains of 1919.

2. The same view as No. 1 taken at the end of the rains of 1919. Shows logs herringboned along the banks preparatory to floating in 1920 rains.

3. The same view as Nos. 1 and 2 taken during the rains of 1921. Shows a well formed floating stream.

Irrawaddy on the west, to 2 to 5 miles east of the Hlaing River. The whole of this depression is annually flooded by Irrawaddy water to a depth of 10′—15′, and into the lake so formed, all the swift flowing, heavily silted, log bearing streams of the Prome, Zigôn and Tharrawaddy Divisions empty their contents, *i.e.*, there is a large basin of more or less clear still water into which the silt bearing jungle streams deposit their silt. This basin may be likened to a large tidal basin with annual tides, which are the rise and fall of the Irrawaddy floods.

Thus, as in the case of tidal estuaries, when the tide or "*laha*" is up, the jungle rivers form a sand bar or "*thegaw*" at high water mark. When the tide falls, the bar is partially scoured out, and moves down stream. This normal condition of an increasing and decreasing sand bar common to all estuaries is here complicated by the deposit of jungle rubbish, logs, etc. These help to form solid permanent barriers, so that the course of the stream varies from year to year. To alter this state of affairs, to stabilise the course of the stream, to secure a clear and permanent flowing channel; and by systematising and regularising silting of the *laha* Zone, to reclaim for cultivation many acres of flooded land, river training was started. In this brief account it is impossible to attempt the description of the evolution of present methods. This has already been done by Mr. Leete, C. C. F., for the period 1909—17, and all that will be attempted is a short outline of present methods and results.

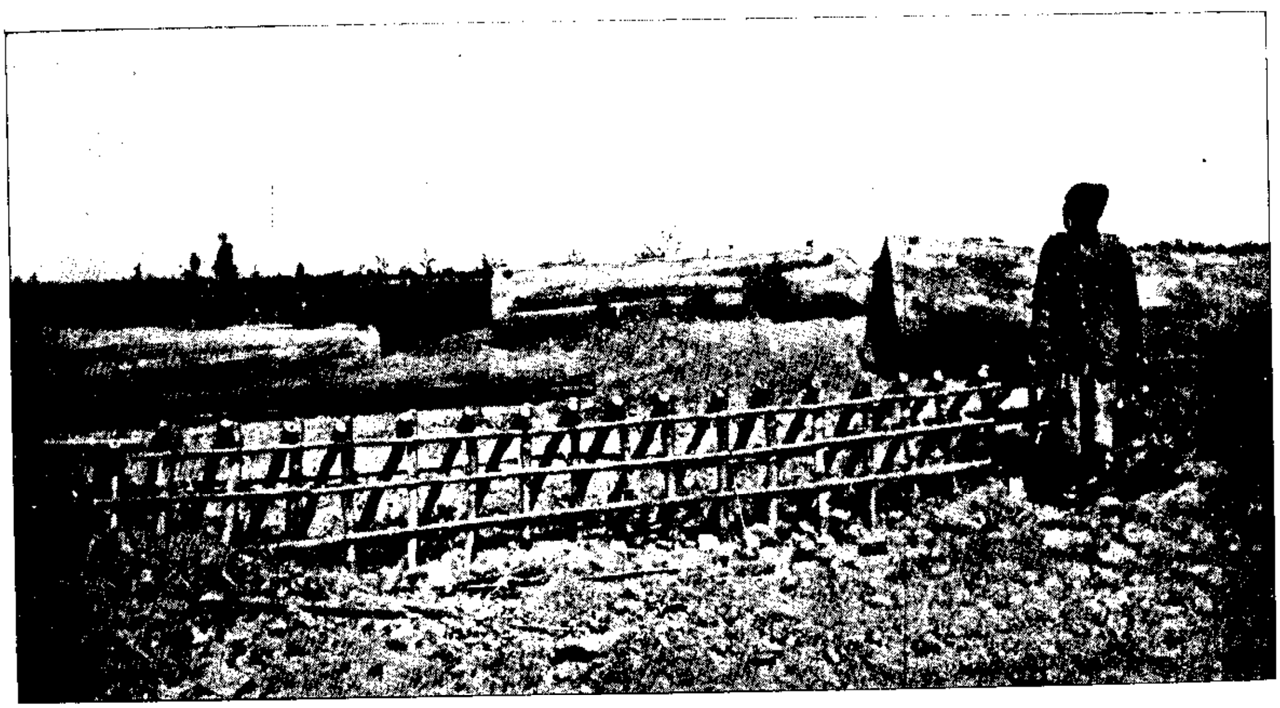
Of the five *thegaws* seen the following three have been selected as types of three phases of the work, and the larger and ultimate problems of the fate of the Hlaing river will not be touched on:—

I. The Myole *chaung* shows the first attacks of river training on a virgin *thegaw*.

II. The Minhla *chaung* shows the type of set back that may be expected from sudden rises of either *laha* or jungle water.

III. The Taungnyo *chaung* is more or less the finished article.

4. The simple fence used for checking flow of water and encouraging silt deposit.



5. A stronger type of bamboo fence used where there is a strong flow of water to be checked.

I.—The Myole Chaung.

1. *Before and after training.*—This year's problem, revealed by the fall of the *laha* on September 1st, was a 400 yard *thegaw* silted dry and covered with logs, while what little current there was, escaped into the *laha* by numerous side channels.

When seen by the writer on 19th September 1922, however, there was a fast running channel some 20′ broad by 2′ deep flowing between even topped gently sloping banks which were some $2\frac{1}{2}'$ above the ground level of 1st June 1922, and this channel stretched for more than $\frac{3}{4}$ of a mile below the top of the original *thegaw*. Within three weeks, a 400 yard obstruction had been removed, and an additional mile of floating stream formed since the beginning of the rains of 1922.

2. *Methods adopted.*—To bring about the above result, the following operations were undertaken: Last cold weather two rows of bamboo pegs 9′ long (6′ driven into the ground) were put down with about 150′ between the rows, the fence being strengthened with a top rail lashed with rope. When the *thegaw* appeared subsequent to the fall of the *laha*, a narrow channel 1′ or so was scraped through the *thegaw*, just to give the water a lead.

Any available logs were arranged in herring-bone fashion some 15′ on each side of this channel. Then as the *laha* receded, the current increased, and gradually scoured out this channel, so that by 12th September 1922 there was a stream 10′—15′ wide and 4″ deep, and on 19th September 1922 this had increased to 20′ × 2′. At the same time as this, scouring in mid channel took place, the slower moving water at the sides, checked by the bamboo fences, was depositing silt, inside, and to a less extent, outside the bamboo fence, every time the stream came down in flood. At this stage great care had to be taken to remove all obstructions from the main channel (even a dead dog will cause a silt bar to form and the bank to breach), and this permanent maintenance of a clear channel is *the vital factor in successful river training*. Given an open channel and a silt laden stream the formation of a permanent channel through level country is assured.

Once you have an open channel you have the three processes of bank formation in continuous action.

(1) The sides of the stream, *i.e.*, inside the two fences, are depositing silt, thus forming even topped, gently sloping and wide banks.

(2) The water passing through the fence is depositing silt to a lesser extent, thus gradually raising the surrounding country (in one place this year's silt was 7′ deep, and the cultivators could only plant paddy by crawling out on planks).

(3) The fast flowing centre of the stream is scouring out the bed and carrying this silt down to form banks further down. (To assist scouring the herring-boning of logs along the bank is most effective.)

Thus the stream itself is continually raising its own banks and deepening its bed; and it is obvious that as this process proceeds more and more, water will be confined to the stream in its higher reaches, to carry its silt on, and form banks further on.

It follows then that each succeeding rise will overflow the banks lower and lower down stream, and as each succeeding rise deposits silt, and raises the ground level, the lengthening of the stream and pushing back of the *laha* limit, is merely a matter of time. This process had of course been going on in an irregular form for years, and river training has merely organised the regular deposit of silt where it is wanted, instead of allowing it to be dissipated at the whim of the floods.

Obviously any alteration in the point reached by the *laha* water moves the point of silt deposit, *i.e.*, the *thegaw* up or down stream and *thegaws* must in the nature of things continue until the *laha* area is filled up with silt and is no longer subject to Irrawaddy floods.

II.—THE MINHLA CHAUNG.

1. *Position after rains, 1916.*—Here by means of high bunds (as described under the Taungnyo Chaung) the *thegaw* had been very slowly moved down stream some mile and a half below where it was when work was started in 1911 and 1912, but there were still considerable difficulties to overcome.

2. *Position in rains, 1922.*—The methods described in above in connection with the Myole were started in 1918 and the channel had been extended and the *thegaw* pushed down some 2½ miles so that at the beginning of the rains of 1922 there was a good channel into the *laha.* In August, however, some 4,000 logs came down on a rise, and jammed at the edge of the *laha*, forming a silt bar or *thegaw* which caused the stream to split up into various subsidiary channels meandering into the *laha.* The actual position at the end of the rise was a jam of 4,000 logs over about a mile of *thegaw*, the channel destroyed for about 1½ miles and the water flowing into the surrounding marshes by half a dozen different outlets.

3. *Methods adopted.*—As already described above the first essential was an open channel, and this was made by man handling the logs into a rough herring-bone formation as already explained. Scouring started at once and as the stream widened and deepened more and more logs were dragged from the top, and herring-boned at the *laha* end.

The jam having occurred at upper limit of the *laha* (as is usual), the construction of bamboo fences (as previously described) had in this case to wait until the *laha* has receded some distance.

The second operation was to remake the banks where breaches had occurred. This was done by packing big logs tightly and in herring-bone formation across each gap, and then putting in semi-circular bamboo fences some 50 to 100 feet back, to check the flow through the breach and induce silting. In one place where the stream showed a tendency to turn north into a low-lying area, a chessboard system of fences, in 50—100 feet squares, had very successful results.

As a result of these operations, it was noticed on 19th September 1922 (after the channel was cleared) that the stream at the head of the jam had already scoured below the level of some of the breaches while at the lower end silting up of the chessboard area was proceeding space.

III.—THE TAUNGNYO CHAUNG.

This being the earliest stream tackled and showing all the different experiments from which the existing method has been evolved requires a rather more detailed description.

It is not possible to give in detail any account of the changing views that influenced this evolution but, briefly, the original high bunds aimed at the creation of a good floating channel by preventing bank overflow altogether, and retaining of all flood water inside the stream limits. This was followed by a policy of low bunds, an attempt to combine land reclamation, by allowing controlled flooding and silting of the surrounding country, with the maintenance of a clear floating channel. From this arose the present "natural," no bund, system already described in parts I and II. The definitely accepted policy now is that river training must be based on a raising of the general ground level and a systematic driving back of the *laha* zone and not on the retention of floods by means of high narrow banks far above the average ground level.

(1) *Past History.*

(*a*) *High bunds.*—These bunds, made in 1915, stretched from the old Thakuttan road to the Tapun Forest Rest House, a distance of 2½ miles and have proved themselves completely effective in so far as they have produced (at considerable cost, Rs. 57,000) a definite swift flowing stream which is as far as can be seen permanent.

The fears of a breach into the old channel at Tagyo have proved groundless, and a permanent and adequate floating channel has been established, thus proving the efficiency of high bunds (*i.e.*, bunds which prevent any water flowing over the banks) as far as the first object was concerned.

With regard, however, to the second object "forcing back the *laha* zone," as no flood water could escape from the bunded channel there was no deposit of silt and therefore no raising of the general ground level, *i.e*, the *laha* had not been appreciably forced back.

(*b*) *Low bunds.*—These were introduced under Mr. Leete's advice in the cold weather of 1916 as being cheaper than high

bunds but adequate for floating purposes while still allowing reclamation to proceed, as floods would be able to top the banks and deposit their silt in all depressions, thus raising the general ground level.

These bunds, however, when actually subjected to heavy floods were found to breach badly so forming fresh channels and reducing the efficiency of the stream for floating purposes, *i.e.*, low bunds were not strong enough to maintain a clear floating stream.

The result of these operations between 1914—1916 had been to move the *thegaw* 3 miles down stream to the " skidder platform," so that at the close of 1916 rains there was a definitely established stream for 4 miles below the Paungde road to the skidder platform *thegaw*, while from there to its old mouth at Mindu the stream was still crooked and badly blocked. A clear waterway to the Myitmaka had not yet been made, and neither high nor low bunds had been completely effective.

(2) *Position in September* 1922.

(*a*) *High bunds.*—These were much as in 1916 with however ample silt banks inside the bund. Irrigation and silting of the paddy fields had also been provided for, by breaching definite cuts faced with bamboo matting and floored with bamboo stakes and sand bags.

(*b*) *Low bunds.*—By judicious levelling and breaching these had also become fully established and the land behind them moderately silted up forming good gently sloping banks fit for permanent cultivation.

(*c*) *The thegaw.*—This had moved right into the Myitmaka and there was a broad, wide, even flowing stream (excellent for floating) all the 6 miles from Thakuttan to the Myitmaka, while the well defined permanent banks gently sloping down into rice fields now reached the banks of the Myitmaka, *i.e.*, the limit of the *taha* zone is now the bank of the Myitmaka. Thus between 1916 and 1922 the floating problem on the Taungnyo has been solved, the reclamation of swamp land is well advanced and the mouth of the stream has changed from Mindu to Ngapizo.

The westward movement of the Myitmaka and the partial silting up of the mouth of the Shwele chaung which have occurred concurrently with these improvements are outside the scope of this article.

(3) *Methods Adopted.*

As already mentioned, neither high nor low bunds having proved completely successful further experiments were necessary, and in 1917 Mr. Cheyne, Divisional Forest Officer, Extraction Division, tried the effect of bamboo fences, as already described in connection with the Myole chaung. (As there is nothing new under the sun, I note that a scheme of this sort died still-born in Mr. Weideman's report of 3rd August 1877.) This simple expedient at once proved its value, each succeeding rise piling jungle rubbish against the fence and causing a heavy deposit of silt inside and on the fence and a gradually decreasing deposit outside. Well defined banks shelving off into level mud flats were thus formed and these were immediately planted up with paddy by villagers. The result of this silting was that what was a 400′ wide cut through *laha* jungle, and running between 3′ fences in the cold weather, became at the end of the rains a well defined stream with naturally formed banks.

This is the basis of all the operation since 1916, the banks so formed being adequate to contain all ordinary rises and maintain a definite floating channel, while at the same time allowing big floods to spill evenly over the surrounding country depositing a level topped layer of silt, which in places may be as much as 6′ or 8′ deep in a year.

Thus both objects have been attained.

(*a*) The removal of the *thegaw* has given a good floating stream.

(*b*) By the even silting of the surrounding country, swamps are being filled, the *laha* zone reduced, and cultivation extended by thousands of acres a year.

C. E. MILNER, I. F. S.

THE MANAGEMENT OF HIGH FORESTS IN THE VOSGES AND JURA MOUNTAINS.

INTRODUCTION.

French forests may be divided roughly into two groups :—

(1) Forests in the plains.

(2) Mountain Forests.

The forests of the plains are worked by area on the Uniform System characterised by the fixity and rigidity of its methods. The mountain forests have hitherto been worked on the Selection System, at first with unregulated fellings and later with a volume yield calculated by the method of 1883 or some modification of that method.

In the Alps and the Pyrenees, it is still the custom to work the forests on the Selection System, this method being deemed most suitable for those regions. But in the Vosges and the Jura Mountains the modern tendency is to work the forests as far as possible on a Uniform System, except in the cases of purely protection forests. It is considered that the Uniform System is practicable and that it gives better height, growth and better timber than could be obtained by the Selection method of treatment.

We have now, therefore, in the mountains of the Vosges and the Juras three types of forest :—

(1) Regular High Forest.

(2) Irregular High Forest in process of conversion to regular High Forest.

(3) Selection and Protection Forests.

The present article deals only with the classes (1) and (2). It does not claim to be a summary of the methods of working of *all* the forests in the Vosges and Juras, but refers to certain forests visited during the summer of 1922.

Reference will be made to the following forests which were particularly studied :—

Communal Forest of Raon l'Étape ...	VOSGES.
State Forest of Celle	
Communal Forest of Le Clerjus ...	
Communal Forest of Chapelle-aux-Bois ...	
Communal Forest of Mont Motier ...	
State Forest of Ban d'Uxegney ...	
Communal Forest of Épinal ...	
State Forest of La Grande Côte ...	JURAS.
State Forest of Mont de la Croix ...	
State Forest of La Fuvelle	
Communal Forest of Malbuisson ...	
Sectional Forest of Vezenay	
Communal Forest of Pontarlier ...	
State Forest of Ban	

The Communal Forests differ from the State Forests in two respects :—

(1) There is always a *quarter in reserve*, set apart as a sort of accumulation of capital to be drawn on in times of need, when for some reason or other the commune requires extra funds.

(2) Greater importance is attached to getting a ***sustained equal annual yield*** as far as possible.

These two points will be considered later. Apart from them, from the cultural and management points of view, there is practically no difference between the State and the Communal Forests and they are therefore considered together.

The differences between the forests in the Vosges and those in the Juras are chiefly cultural. In the Vosges the soil consists of Vosgian grit—sandstone and conglomerate—of the middle Triassic horizon. The soil is not very good and in exposed places becomes very dry and poor. In the Juras the soil consists of Jurassic limestone. This is a much better soil, as shown by the much richer, semi-alpine, ground flora. The altitude of the forests in the Vosges ranges approximately from 200 to 700 metres above sea-level. In the Juras the average height of the forests is 1,000

metres or a little over. Again the Juras are farther south than the Vosges, resulting in a different climate.

These differences are naturally reflected in the forests, chiefly in the composition of the crops, the general cultural methods and the length of the rotation. There are more broad-leaved forests in the Vosges than in the Juras, and several were visited. No broad-leaved forests were visited in the Juras, although quite a number exist. The coniferous Forests of the Vosges (Raon l'Étape and Celle) consist practically of pure silver fir, which grows best below 800 metres, while in the Juras spruce is the dominant species, the proportions ranging from 80 per cent. spruce and 20 per cent. silver fir in the Forest of La Grande Côte to 40 per cent spruce and 60 per cent. silver fir in the Forest of Pontarlier. In higher levels also the rotation is longer than in lower levels, owing to the shorter growing season and the decreased rate of growth in the higher altitudes.

Systems of Management and Sub-division of Forests.—With the exception of the Forest of Mont Motier (¾ of which is worked as Coppice and ¼ as a 'reserve' High Forest), all the forests under consideration are worked as High Forest under the *Uniform System*. But the uniformity is more theoretical than practical, for the actual forests do not have the regular succession of age classes typical of the Uniform Forests of the plains. Those still in the process of conversion from Irregular to Regular Forests have naturally considerable irregularity, but irregularity is also present to a greater or lesser extent in the forests in which the conversion is considered as complete.

This is because:—(1) They are Mountain Forests in which it is impossible to have the regularity of forests in the plains, (2) They have previously been treated as Selection Forests or have been under more or less Unregulated Fellings. Owing to the danger of damage by wind and storms, the forests are irregular, old trees occurring in all compartments. No whole compartment is even-aged, but portions are even-aged, especially in the valleys and on protected slopes. The appearance of the forests is therefore intermediate between that of a true Selection Forest and a typical Uniform Forest.

The Forests of Chapelle-aux-Bois and Epinal are the only ones of those visited which have the regularity of the typical Uniform Forests of the plains. Both these forests are broad-leaved and are fairly low down in the Vosges Mountains. Each has 4 fixed permanent Periodic Blocks, each in a compact mass and the whole forest shows a good regular succession of age classes. This system of management is very rigid, and it is doubtful whether the majority will ever reach, or that it is desirable that they should reach, a state of uniformity sufficient for the application of such a method. In the present irregular condition of the crops, the method of fixed permanent Periodic Blocks is very inadvisable.

This has been demonstrated very clearly in the cases of the Forests of Pontarlier and Ban. These were formerly Selection Forests, and when it was decided in the middle of last century to convert them to regular High Forests, the system adopted was that of fixed, permanent Periodic Blocks. The yield was fixed in the usual way by dividing the total volume of the block under regeneration by the number of years in the period. But it was soon found that this yield could not be taken from the block allotted for regeneration during the period, for the block contained much young wood as well as old wood, while in the rest of the forest there was much old wood crying out for regeneration. The regeneration period had therefore to be lengthened by the adoption of the method of Coupes Jardinatoires (see note in the paragraph "Silviculture"), and improvement fellings had to be very heavy in many parts of the forest, taking the form almost of regeneration fellings. Also windfalls were numerous and since no arrangement had been made to allow for them, they often absorbed most of the yield. The result was that after the first two or three periods had passed it was found that not a single block had been regenerated completely although several had been commenced. In the young crops there were many old trees, which should have been removed as intermediate or final fellings long before, and whose extraction would be very difficult, and would cause considerable damage to the young trees around them.

We see, therefore, that the method of fixed, permanent Periodic Blocks in the conversion of an Irregular to a Regular High Forest is doomed to failure. Some sort of a Quartier Bleu method must be adopted, so that regeneration can be carried out in the parts of the forest where it is most needed. The yield must be based on the volume of the whole forest, owing to the irregularity of the crop. Arrangements must be made to allow for windfalls and to ensure that regeneration will not be completely stopped any year because of them, and in the case of Communal Forests, where a sustained equal annual yield is required, improvement fellings must be by volume and not by area.

In the various forests visited there were several methods of treatment which may be classified as follows :—

(1) Periodic Blocks permanently fixed, each in a compact mass (Raon l'Étape, Chapelle-aux-Bois, Ban d'Uxegney, Épinal, La Fuvelle).

(2) Periodic Blocks all fixed, but each not in a compact mass (Malbuisson).

(3) Only the first Periodic Block fixed—a *Quartier Bleu*, the rest of the forest being treated as one—a *Quartier Blanc* (Le Clerjus and ¼ of Mont Motier).

(4) The first and second Periodic Blocks fixed—*Quartier Bleu* and *Quartier Jaune*, the rest of the forest forming a *Quartier Blanc* (La Grande Côte, Mont de la Croix, Vezenay, Pontarlier and Ban).

In each case there is a definite Periodic Block for regeneration and the rest of the forest, either divided up or not, for thinnings, cleanings and improvement fellings. The '*Quartier Bleu System*' as commonly known is not present here, for in (3) and (4) the Quartier Bleu is completely regenerated in the period of the Working Plan, and is not a floating periodic block too big to be regenerated entirely in the period. In (1), (2) and (4) where the Periodic Block next for regeneration is marked out, this can be specially treated to prepare it for regeneration.

As a result of the irregularity of the forests, Improvement Fellings in the parts of the forest not under regeneration are very important and include '*extractions*' of old trees which are over the

girth limits laid down in the working plans. And in the portions under regeneration, the best is done for each compartment, according to its condition, to regenerate the crops.

Calculation of the yield.—The yield is calculated on either an area or a volume basis. In the majority of the forests it is fixed by volume, this being necessary because of the irregularity of the crops. In the case of Communal Forests it is also necessary to have a total volume yield to ensure an equal annual volume return throughout the period.

(1) *Yield fixed by Area—Based on the Periodic Block under Regeneration.*—This is the typical method employed for regular Uniform forests and is used in the cases only of the two more regular forests: Chapelle aux Bois and Épinal. The volume of the block under regeneration—an allowance for increment on the whole volume for half the period, is divided by the number of years in the period, which gives the annual yield for the regeneration fellings. The rest of the forest is worked over by area with improvement fellings on a definite cycle.

(2) *Yield based on the volume of the whole Forest.*—This is the '*French Method of 1883*' and depends on the fact that in a 'normal' forest (which is fully stocked and has the correct proportions of age classes) the volumes of the oldest third, the middle aged third and the youngest third of the crop bear to each other the ratio 5: 3: 1, and in a forest this is the proportion aimed at. The volume of the youngest third of the crop is usually not considered.

The method could not be applied to truly Uniform Forests, since it is dependent on the supposition that the girth or diameter of a tree is proportional to its age, which is not so in such forests. But it is applicable in these irregular or semi-irregular forests, since to a certain extent age and girth *are* here proportional.

The girth limits of the youngest, the middle-aged and the oldest thirds of the crop are determined by the average measurements corresponding to ages equal to one-third, two-thirds and the whole of the rotation, respectively. In many cases the girth corresponding to an age equal to the total rotation is 1·80 m., and the classes are (1) 0—60 cms. girth, (2) over 60 cms. and up to 1·20 m., (3) over 1·20 m.

An enumeration is made of all the trees in the forest, either by girth classes of 20 cms., or by diameter classes of 10 cms., which come in the groups (2) or (3), *i.e.*, all trees over 60 cms. girth would be measured. Then from the local volume tables, or from the actual measurements of sample trees, the average volume for a tree of each girth or diameter class is found. This volume multiplied by the number of trees in the class gives the total volume for that class, and by addition of the volumes, the volume of each group is found.

(*a*) Volume of oldest third $= x$.

(*b*) Volume of middle-aged third $= y$,

Now if the forest is normal, then we will have the ratio $x : y = 5 : 3$.

If x and y have this ratio, then all is well and good, and the yield is based on x, which is the volume of the oldest third of the crop.

Let i be the average annual increment of the oldest third. Then the *Total Exploitable Volume* for the next $\frac{1}{3}$ of the rotation is given by :—

$$x + \left(\frac{1}{2} \times \frac{i}{100} \frac{r}{3}\right)$$

Therefore the *Annual Yield* =

$$\frac{x + \left(\frac{1}{2} \times \frac{i}{100} \frac{r}{3}\right)}{\frac{r}{3}}$$

To this must be added something for the improvement fellings which will be carried out in the middle-aged third. As a rule it is reckoned that $\frac{1}{2}$ (sometimes only $\frac{1}{3}$) of the annual increment will be removed. Let i^* be the increment for the middle-aged third. Then the extra yield will be :—

$$\frac{1}{2}\, y \, \frac{i^*}{100}$$

Therefore the *Total Annual Yield* =

$$\frac{x + \left(\frac{1}{2} \times \frac{i}{100} \frac{r}{3}\right)}{\frac{r}{3}} + \frac{y}{2} \frac{i^*}{100}$$

Suppose now that x and y are not in the proportion $5 : 3$. Then from the total volume the theoretically correct proportions

are found, $x^1 : y^1 = 5 : 3$. Then x may be greater or less than x^1, according as the old wood is in excess or in deficit. Let the difference between x and x^1 be A. Then if the old wood is in excess, a volume A is transferred from the oldest third to the middle-aged third and the effective volumes taken will then be $x - A$ and $y + A$. Similarly, if the old wood is in deficit, a volume A will be transferred from the middle-aged third to the oldest third. We then get the modified equations :—

Old wood in excess—Yield $= \dfrac{(x - A) + \dfrac{(x-A)\,i\,r}{2\;100\;3}}{\dfrac{r}{3}} + \dfrac{(y + A)\,i^*}{200}$

Old wood in deficit—Yield $= \dfrac{(x + A) + \dfrac{(x+A)\,i\,r}{2\;100\;3}}{\dfrac{r}{3}} + \dfrac{(y - A)\,i^*}{200}$

This yield is that for the whole forest, since it is based on the volume of the whole forest. The practical result of the transference of the volume A from the oldest third to the middle-aged third, or *vice versâ*, is that either some of the trees of the oldest third will not be removed until the next third of the rotation, or that some of the trees of the middle-aged third will be removed before their time in the present third of the rotation. Individual trees are not of course definitely selected for this, but it means that the removal of the oldest trees will be either retarded or accelerated. Before any transfer is made, it has to be considered for each forest whether the theoretical uniformity given would be of sufficient value to warrant such an exchange.

Distribution of the Yield.—There are several different methods of distribution of the yield and they are complicated by the various methods of allowing for the windfalls and dead wood (chablis) and by the ¼ reserve in the Communal Forests. Both of these are explained in detail in the next paragraphs.

The simplest cases are those of the forests of Chapelle aux Bois and Épinal. In each of these forests the yield is fixed by area. This is applicable only to the block under regeneration. Improvement fellings are therefore done by *area* and no definite annual yield is fixed for them at all. Of the regeneration yield, in each case ¼ is deducted for the ¼ reserve, since the forests are

Communal ones, and the remaining ¾ is used for regeneration, windfalls being first deducted from it each year.

Almost as simple are the forests of Raon l'Étape, Celle, Le Clerjus, Ban d'Uxegney and Ban (old working plan, new one now in process of formation). After the deduction of ¼ of the yield for the reserve, in the cases of the Communal Forests, the method of marking the yield is as follows :—

(1) In spring all the chablis are removed and deducted from the yield.

(2) Next improvement fellings are done by area (prescribed order of compartments on a 10 or 12 year rotation), and deducted from the yield.

(3) Any remaining yield is then used for regeneration fellings.

This method is very simple, but is very bad as the regeneration fellings are hampered by both the windfalls and the improvement fellings and often there is very little or nothing left of the yield for them.

In the forests of La Grande Côte, Mont de la Croix, Vezenay and Pontarlier, the yield is divided up between the regeneration and the improvement fellings according to the proportion of the old wood to the middle-aged wood and its distribution through the forest, and windfalls, are deducted from the regeneration or improvement yields according as they occur in the regeneration area or out of it. The forests of Vezenay and Pontarlier are Communal Forests and therefore the ¼ reserve was taken out of the yield for regeneration fellings after the distribution had been made.

Lastly there is the method with the *Technical Reserve* for windfalls (Forests of La Fuvelle and Malbuisson). The technical reserve (about 3,000 cu.m.) is first deducted from the exploitable volume before the yield is calculated. Then the yield is calculated and is divided up as follows :—

(1) ¼ Reserve, (2) Regeneration Fellings, (3) Improvement Fellings, (4) Windfalls. Any variation from the windfall yield in the amount of windfalls any year is absorbed from or by the Technical Reserve.

The Regeneration Yield is obtained by dividing the volume of the trees in the area under regeneration by the number of years in the period. The Windfall Yield is taken as the average annual amount of windfalls. The rest of the yield will then go to improvement fellings, *e.g.*,

FOREST OF LA FUVELLE.

Technical Reserve = 3,000 cu. m.	
Total yield, after deduction of the Technical Reserve from the Exploitable Volume	= 992 cu. m. p. a.
Annual yield calculated for the *Regeneration* Area from its volume ...	= 560 ,, ,,
Average annual *Windfalls* ...	= 230 ,, ,,
Therefore yield for *Improvement Fellings*	= 202 ,, ,,
Total ...	992 ,, ,,

This is a State Forest and therefore there is no ¼ reserve. In the case of the Forest of Malbuisson, which is a Communal Forest, ¼ of the yield is reserved.

The differences between these methods are due to different methods of allowing for windfalls, and improvement fellings, which are summarised in the following two paragraphs:—

METHOD OF ALLOWING FOR WINDFALLS.

(1) *Forests with a single yield* for Regeneration and Improvement Fellings.—Here the windfalls are deducted from the yield before anything else is done. Both types of felling may therefore be affected. As a rule Improvement Fellings come next and Regeneration Fellings last, but it may be left to the discretion of the Forest Officer or a definite proportion may be laid down.

(2) *Forests with two yields*, one for Regeneration Fellings and one for Improvement Fellings.

Windfalls may be distributed in 3 ways :—

(*a*) One-half deducted from the Regeneration Yield and one-half from the Improvement Yield.

(*b*) In proportion to the quantity of old material in different parts of the forest.

(*c*) Distribution according to locality; those windfalls in the Regeneration area being deducted from the Regeneration Yield, those in the rest of the forest from the Improvement Yield.

(3) *Method of the Technical Reserve.*—A separate part of the exploitable volume is set apart as a Technical Reserve, before the yield is calculated. The yield, calculated on the exploitable volume less this amount is then divided up into—

(1) Regeneration Yield, (2) Improvement Yield and (3) Windfalls Yield.

The Technical Reserve is a floating fund to absorb irregularities in the windfalls. If in any year the windfalls are greater than the yield set aside for them, then the excess is deducted from the Technical Reserve. If they are less than the yield allowed for them, then the balance is added to the Technical Reserve, which is revised each time the yield is revised.

The method of the Technical Reserve is not always considered a success, although it was introduced at the last revision in the forest of La Fuvelle. Method (2) (*c*), which may be called the *Distribution by Locality Method* is probably the best, as it minimises dislocation of improvement or regeneration fellings.

IMPROVEMENT FELLINGS.

(1) *No definite yield allocated.*—After deduction of windfalls from the inclusive yield, we have several methods of allowing for improvement fellings—

(*a*) Carried out by *area* on a definite cycle and the volume so removed deducted from the yield.

(*b*) Improvement Fellings and Regeneration Fellings to be carried out in a *definite proportion* as laid down in the Working Plan.

(*c*) The proportion of the Improvement and the Regeneration Fellings left to the *Forest Officer's discretion.*

(2) *Definite yield for Improvement Fellings*—

(*a*) Based on the proportion of the old to the middle-aged wood in the forest and its distribution through the forest.

(*b*) Based on previous experience of the average annual yield of improvement fellings.

(*c*) The Regeneration Yield fixed by the volume in the regeneration area, and the improvement fellings taken as the rest, after deduction if necessary for windfalls (technical reserve method).

THE QUARTER RESERVE OF COMMUNAL FORESTS.

It is compulsory in Communal Forests that one-fourth should be left 'in reserve' as a sort of reserve fund which can be drawn upon at times when the commune has particular need of money. The value of this system has been clearly demonstrated since the war, when many villages and towns have needed extra funds for reconstruction purposes.

The one-fourth reserve may be left in two ways:—

(1) *A quarter of the area set apart and definitely reserved.*—This is the case in the Forest of Mont Motier. Three-fourths of the area is worked as a coppice, while one-fourth is the reserved area and is worked as a High Forest. No fellings are made in this area except as 'extraordinary fellings' from the reserve as granted by the Forest Officer. These fellings are either improvement or regeneration fellings according to the needs of the forest.

(2) *A quarter of the calculated yield is reserved.*—In the cases where there is a Technical Reserve for windfalls, this Technical Reserve is first deducted, then the yield is calculated and one-fourth of this is set aside as the reserve (*e.g.*, Forest of Malbuisson). In other cases

where there is no Technical Reserve, one-fourth of the calculated yield is simply deducted for the reserve.

The one-fourth reserve is always taken from the Regeneration Yield and it can only be removed in the form of Extraordinary Regeneration Fellings. In some cases a definite order of compartments is given for regeneration if and when extraordinary fellings are granted. Thus at Epinal, in the Communal Forest, the Regeneration Yield is fixed on the volume of the first Periodic Block in the typical Uniform method. One-fourth of this is put aside as reserve, so that without removing any of this reserve only three-fourths of the Periodic Block under regeneration would be regenerated. A single order of compartments is given. When Extraordinary Fellings are granted, they are made in continuance of the ordinary fellings. In the Forest of Vezenay, two-thirds of the yield is given for Regeneration Fellings and one-third for Improvement Fellings. The one-fourth reserve is taken from the Regeneration Fellings, so that we have—

2/3	Ordinary Regeneration Fellings ...	5/12 of the total yield.
	Extraordinary (1/4 Reserve) Regeneration Fellings	= 1/4 " " " "
	Improvement Fellings	= 1/3 " " " "

SILVICULTURE.

Regeneration Fellings in the Coniferous Forests.—In the coniferous forests (spruce and silver fir), both in the Vosges and Juras, natural regeneration is very good. Seedlings of silver fir are intense shade-bearers and therefore establish themselves under the old crop as soon as this begins to open out naturally as it approaches maturity. Often therefore, *no seed felling is necessary*, but regeneration can proceed at once with a secondary felling. When spruce is present, this secondary felling enables the spruce seedlings to establish themselves as they require more light than silver fir seedlings. Usually only one more secondary felling is required 8 or 10 years later, followed about another 10 years later by the final felling. In the forest of Raon l'Étape, some striking examples were seen of the complete destruction of a

perfect dense natural reproduction of silver fir, by the too sudden and entire removal of the overhead trees.

Strip Fellings.—These have been attempted in the State Forest of Mont de la Croix and also in a private forest (forest of La Fresse) which was visited. In the latter case they were a complete failure due to—

(1) strips were too wide for silver fir, the species present, which requires shade for the growth of its seedlings,

(2) the strips were badly orientated (to conform with the map),

(3) the strips were widened by windfalls at the edges due to exposure,

(4) seed years were bad and a great growth of weeds sprang up.

In the forest of Mont de la Croix better precautions were taken, but the experiments were failures, since silver fir and spruce seedlings require more shade, and also the wind gets in the strips and blows down all the trees along the edges.

Beech.—This is present in small quantities in the coniferous forests. The species is being encouraged as a soil improver, but only in so far as it does not interfere with the development of the spruce or silver fir regeneration. It is, therefore, chiefly encouraged as an undergrowth to the coniferous crops.

Weymouth Pine.—This has been planted with considerable success in the damp and boggy parts of the forests of Ban, d'Uxegney and Epinal in the Vosges. It reproduces well, clear fellings in small groups having been made, but suffers a bit from fungal disease (*Cronartium ribicola* = *Peridermium strobi*). In these forests there is a separate yield for the Weymouth Pine, quite distinct from that of the rest of the forest.

Coupes Jardinatoires.—The system of felling by Coupes Jardinatoires corresponds to the Swiss and German Femelschlag method. It has been introduced in some of the forests under consideration because the blocks under regeneration contained a considerable amount of middle-aged trees which had not yet reached maturity. To save felling this material while it is still young and is putting on good increment, the trees have been left

in small groups, only the older ones being felled. These small groups are then felled some time in the next period. This corresponds to a lengthening of the period of regeneration to allow the smaller trees in the area to put on a girth increment after the bigger ones have been removed.

The method can work very well, as is shown in some of the Swiss forests, notably at Bienne, but in the Vosges and Juras, it does not seem to have met with great success. This has usually been because no definite prescriptions have been given in the Working Plans for the removal of the trees left standing. Consequently Final Fellings were delayed and regeneration was never completed. In some cases (Pontarlier and Ban) no compartments have been completely regenerated in the last two or three periods, because of the adoption of this method of Coupes Jardinatoires, coupled with dislocation caused by having no arrangement to prevent windfalls swallowing all the regeneration yield. The removal of the older trees left in the partially regenerated compartments is very difficult and causes considerable damage to the young crops.

E. C. MOBBS, I F.S.

A NOTE ON THE EXPERIMENTS MADE IN THE CHITTOOR DISTRICT, MADRAS PRESIDENCY, WITH ATLAS A PRESERVATIVE.

Atlas A preservative can be procured from Messrs. W. Crowder and Co., Ballard Road, Bombay, in one and five gallon drums at Rs. 12 and Rs. 54 per drum respectively, ex-godown delivery. I have never bought the single gallon drum as it works expensive and the quantity is too small for useful experimental work.

2. As a result of some correspondence I had with Messrs. Crowder, I got them to give me a discount of 5 per cent. and later on I secured a further discount of 5 per cent. (to cover distribution charges) because others besides myself had to use the stuff and I promised if it proved successful in the experiments that I was carrying out to influence outsiders, *e.g.*, ryots and District Board Engineers to go in for it for the destruction of

prickly pear. This 10 per cent. came in handy and reduced the cost of a five gallon drum to little over Rs. 50 all charges included.

3. Orders should be directed to be booked by goods train as otherwise the railway freight is excessive.

4. On receipt, drums are frequently found to be leaky and I would advise that in such cases the contents be at once transferred to good kerosene oil tins and the drums made use of otherwise. I have conceived the idea of cutting out the tops of such drums, rivetting stout iron handles on the sides and supplying one or more such to each rest house as a water boiler—a most useful article for a camping officer to find in a bungalow. Of course leaks are all stopped up with lead solder which is not affected by water. Good drums ought perhaps to fetch Rs. 2. to Rs. 2-8-0 if sold, and this would reduce the cost of the poison, but so far I have not tried to sell any.

5. My first experiments with " Atlas " were made in order to assist certain *panchayatdars* who complained that the area given to them was full of *seegi* (*Pterolobium*), which detracted from its value as a grazing ground. For the idea itself, I am indebted to Mr. Allen (once Extra Deputy Conservator of Forests, Burma) who some years ago wrote a note about this stuff in the *Indian Forester*, and the complaint of the *panchayatdars* synchronising with the receipt of a catalogue from Messrs. Crowder made me write off for a five gallon drum; that was in August 1921. Atlas A preservative is not advertised as a tree killer but as a wood preservative, but Mr. Allen noted that it not only kills the tree but preserves the wood at the same time ; it was however obvious from his note that he could not give proof of this latter assertion.

6. One of my earliest experiments (September 1921) with Atlas was made with a view to testing Mr. Allen's statement, and for this purpose I took up a very large tree of *Ailanthus excelsa* in the compound of the Palmaner rest house and very close to the kitchen buildings. This tree and another in same compound had proved to be a great nuisance for they annually produced a huge crop of wool worms, which used to freely find their way into the

out-houses and into the bungalow also, much to the discomfort of the occupants. The tree near the kitchen was girdled, but not deeply, and the surface of the girdle liberally painted with pure Atlas in September 1921. The other tree was left intact. The girdled tree has been examined from time to time, the last examination having been made in September 1922. The first thing that happened, within a few weeks, was that a dark coloured fungus looking growth made its appearance on the girdled surface; this, in some places was in streaks and in others in patches. Later it was observed that the bark (*Ailanthus* has a pretty thick bark) was drying up, and cracking in the vicinity of the girdle, but much more so above than below the girdle. These cracks went on extending upwards and as this continued, pieces of bark broke away, and the branchlets dried up. In September 1922, the bark from practically the whole of the bole (about 10 feet) above the girdle had come away, and a good deal from below the girdle also; the cracking of the bark had extended to the branches and in the case of some of the big branches a good deal of the bark had fallen off, the branchlets had all died and fallen away leaving the ends of the branches struggling to throw out small shoots and a few leaves. The whole of the crown has a restricted sickly appearance and it will not now be long I think before every branch loses all its bark and dies entirely. Only two weak looking shoots have made their appearance, one a little below the girdle and another closer to the ground, these appeared first to my knowledge about the end of January 1922 and since they have hardly put on any development since, they will probably not come to anything. But whether they do or not is immaterial because my object is merely to test whether the poison has really improved the wood and if so in what direction and to what extent. This cannot now be ascertained but as soon as the tree entirely dies, I intend sending duplicate specimen of wood (one from the poison and one from the untouched tree) to specialists for examination. I also intend burrying one specimen from each tree in an ant-hill.

7. *Experiments made to kill out thorny creepers.*—On 29th September 1921, in the Gollapalli *panchayat* area, myself and the

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Ranger with the help of a forest guard cut blazes around the bases of 47 *Pterolobium* and 4 *Zizyphus Œnoplia ;* the blazed surfaces were about six inches long and as near the ground as convenient ; these surfaces were then painted with pure Atlas. On this we expended a small bottle of the poison, measured to be one-twelfth of a gallon.

The same area was again visited on 15th October 1921, the previously attacked trees were examined, in every case the leaves had dried up and were being shed.

Eight coolies were ready on this day and as it was my intention to give the *panchayatdars* a demonstration they had also turned up. The coolies under the superintendence of those men were set on to uproot *Pterolobium* while myself with the Ranger and three coolies undertook the poisoning. The work was timed for 2 hours. We again utilised one-twelfth of a gallon of poison and operated upon 53 *Pterolobium* and *Zizyphus* bushes, some of which had a basal stem six inches in diameter. The coolies in the meantime had done only 24 *Pterolobium* bushes and naturally they had selected only those which were comparatively small and easily get-at-able. All the 51 stems which we poisoned on the 29th September and the 53 which were done on the 15th October were then pegged and numbered.

The same area was again inspected on the 1st December 1921 and as far as it was then possible to tell, every poisoned climber had completely died ; a few (three) of the largest were uprooted and it was found that even the roots were quite dead. In the pits from which *Pterolobium* had been uprooted, small shoots were making their appearance from the cut root surfaces.

One final inspection was made on the 10th March 1922 when I found, to begin with, that people had got into the area and felled and removed many of the dead stems ; the pegs had also in many cases disappeared. However I was able to find 63 poisoned stems and of these 25 had thrown out shoots from near the base, in *every* case the shoots appeared from below the poisoned surface. In some cases the shoots were vigorous, in others weak and sickly looking. Both big and small stems which had thrown out shoots and both big and small were found to have died out com-

pletely. It was particularly noticed that most of the stems which had thrown out shoots were in stony, rocky ground where proper barking right round the stem had been a difficult process in consequence of which the poisoning was in all probability incompletely done. On the flat practically every tree had died.

Adding the three dead trees which were uprooted on the 1st December 1921 we get, in this case, complete death in 41 out of 66 items or 62 per cent. of complete success; but I think it is only fair to assume that the percentage of success would have been much higher if I could have found the other trees for, as stated, people had been in and had cut away the dead stems for fuel and in the absence of the pegs it was easier to find a stump with shoots than a stump without. However that may be, the only way of trying to get rid of *Pterolobium*, apart from the poisoning method is by uprooting it and on the 10th March 1922 I examined all the 24 pits from which that pest had been uprooted and in every case I found more or less vigorous shoot s along the sides of the pits. Quite apart, therefore, the cheapness and ease of working with Atlas, it is the only way of killing out *Pterolobium*.

In concluding this paragraph I must mention that not a single *Zizyphus* which had been operated upon with poison had thrown up any shoots.

8. Having had considerable experience of working with Atlas preservative and having watched the results of so many experiments made with the poison not only in connection with *Pterolobium* and *Zizyphus* but also with *Lantana* and prickly pear I came to the conclusion that the best results will only be obtained :—

(1) If we work in the hot weather when the sap is low down and the vitality of the plants is at its lowest and (2) if we girdle the trees right low down, if possible even removing the earth from round the base of the tree and then do the girdling. In the case of the experiments referred to in the previous para, the poisoning was done in September and October which are, according to my conclusions,

about the worst months in which such work ought to be undertaken and had it not been for the fact that the Madanapalli taluk receive mighty little rain even from the North-East monsoon, those experiments would probably have proved a complete failure. It must be remembered that "Atlas" is easily soluble in water, so easily indeed that a gust of moisture laden wind carries the stuff and deposits it on areas not touched by the experiment; this I have found happen in Panapakkam where after spraying several prickly pear plots with it on a damp day, a fortnight later I found all the pear for a considerable distance on the leeward side poisoned and looking quite yellow. Not only therefore is it necessary to do the work in the hot weather so as to catch the tree when it is least able to resist but it is also necessary to stick to the hot weather months in order to obviate the likelihood of the poison being dissipated.

9. In order to further test the accuracy of the above conclusions the following further experiment was made :—

On 12th July 1922, 30 stems of each of the following species were selected in the Panapakkam Reserve Chandragiri Range and poisoned over blazed surfaces cut as low down as possible after removing the earth from around the base of the stems for a depth of about 6 inches.

Pterolobium indicum	...	... *yerra seeki.*
Zizyphus Œnoplia	...	... *pariki.*
Acacia Intsia	...	... *thella seeki.*
Pisonia aculata	...	... *konkai.*
Capparis sepiaria	...	... *nalla vopili.*

They were inspected on 23rd July 1922 and all were found to have wilted. They were again inspected on 4th August 1922 and it was found that the smaller ones appeared quite dead while the others were dying. They were again inspected on 9th

September 1922 by the Ranger who reported that the following were living but looking very sick :—

nalla vopili	..	...	13
pariki	...	...	1
thella seeki	...	...	5
yerra seeki	..	...	nil.
konkai	...	...	3

In all the others neither did the stems show any signs of life nor were there any shoots from the base. The Ranger adds the following remarks :—

"Except in the case off *nalla vopili* which even when completely stripped off bark survive I find in the other cases that the cambium layers (sic) are not completely removed owing to deep furrows at the bottom of the stem or to the stem leaning on the ground for some distance."

In the case of this experiment I must mention that there had been practically no rain in this district from July onwards; the season was an exceptionally dry one and this probably accounts for the complete success with *Pterolobium*. It is unfortunate that in the other cases the barking was not properly done, and if the killing out of these thorny pests is to be undertaken anywhere on an extensive scale I would strongly advise as a safeguard against the scamping of work in the above direction, that in every case in which the base of the plant is furrowed or is recumbent on the ground, that it be insisted upon, that the stem be cut across about 6″ from the base and the basal portion then barked and the poison painted not only on the barked surface, but also on the cut section.

10. In addition to the above experiments the following were poisoned in the Avalakonda reserve on 14th April 1922 adopting the same method:—

25 *thella seeki*.

25 *yerra seeki*.

27 *pariki*.

8 *merapakandra* (*merapakandara*).

8 *puriti*.

These have not been inspected by me properly since then, but in June 1922 when the other District Forest Officers came round for the conference we went to this place, and the stems that we saw appeared to be quite dead.

11. Summing up the experiments made on thorny climbers the following conclusions and figures of cost are recorded :—

(*a*) Taking a gallon of poison to cost Rs. 10-8-0 at work spot, about one-sixth gallon of poison costing Re. 1-12-0 is required for 100 stems of all sizes.

(*b*) Eight men in two working hours can do the barking around and the painting of 100 stems. Allowing 8 working hours per day and 5 as. per day per man, labour costs 10 annas.

Total cost per 100 stems Rs. 2-8-0.

(*c*) Pure poison should be used.

(*d*) Powdered chalk should be added to the poison before use, as this on drying, will show a white surface, and enable one to decide whether a particular tree has been painted or not.

(*e*) Work should be done on a dry hot day, at the beginning of the dry season, if the best results are to be secured. Quicker and more satisfactory results are obtained from stems out in the open exposed to bright sunlight rather than from those in dense moist jungle.

(*f*) The bark must be *completely* removed from *all round* the stem for a length of at least six inches and as near the ground as possible. Pure poison should then be painted on all over the barked surface. The nearer the barking is done to the ground the better and where practicable the earth around the base of the stem should be dug away so as to facilitate very low girdling.

(*g*) In the case of many of these climbers (particularly *Pterolobium*) we frequently get a very short—even less than a six inch—main stem and they are frequently found on stony ground which does not admit of a hole being dug around the base ; in such cases and in cases

in which the bases of the stems are furrowed it is necessary to cut across the stem 4 or 5 inches above the ground, then bark all round the stem and then apply the poison not only to the *barked surface but also to the cut section.*

The same thing must be done when the lower end of the main stem is lying prone upon the ground.

(*h*) Provided work is done on a dry day in the hot weather, and provided the barking and painting is properly done as described above, cent. per cent. success can be assured in the cases of all the following climbers: —

(1) *Pterolobium indicum.*

(2) *Zizyphus Œnoplia.*

(3) *Acacia Intsia.*

(4) *konkai* (*telugu*).

In the case of *nalla vopili,* however, it appears that we can only expect about 80 to 90 per cent. of success.

12. It was a little time after commencing operations on thorny climbers, that the idea struck me to try the poison on prickly pear.

The very first thing done was to dab (with a brush) pure poison on very small prickly pear a foot high. Isolated shoots of pear were operated upon and the dabbing was made on the uppermost cladodes. In a week's time the shoots, roots and all had become quite rotten and soon after there was nothing left of them. This was in good dry weather at the end of September in Madanapalli.

Noting results on the small pear, I dabbed with pure poison several of the cladodes of a huge clump of pear about 7 feet tall. The poison from those cladodes was evidently absorbed by the whole stem and within a fortnight what was an erect bush of pear had become very like what one might imagine to be the same bush attacked by a severe form of leprosy, all the upright branches had lost their rigidity and were drooping over.

I saw the same bush a couple of months later, and there was very little left of it, but from the lower thick portions new shoots had begun to sprout.

In the meantime, *i.e.*, on 7th November 1921 one-twentieth of an acre (roughly measured) of very dense prickly pear near the Gadanki village was sprayed over with a solution of poison (1 of Atlas to 3 of water). In this case the quantity used was measured and it was found that at that strength it would cost about Rs. 150 per acre for poison alone.

On 8th November 1921 three patches of prickly pear near the rest house at Panapakkam were sprayed over with poison using 1 to 4, 1 to 5 and 1 to 6 solutions, respectively.

On 10th November 1921 four patches in the same locality were sprayed over with solutions of poison made with boiling water using 1 to 3, 1 to 4, 1 to 5 and 1 to 6, respectively.

On 16th November 1921 three patches were sprayed over in the same locality with cold solutions made up 1 to 10, 1 to 15 and 1 to 20 respectively.

Note.—The spraying was done with an ordinary garden hand spray.

In all the above cases it was noticed that in from 3 to 7 days, (varying according to the strength of the solution and the size of the pear) the pear assumed a sickly reddish appearance, which gradually assumed a yellowish tint as decay proceeded.

Observations were made from time to time thereafter but it was exceedingly difficult at each observation to point out to any particular difference between the plots, the sum total of these observations are therefore put down as follows :—

(1) With small prickly pear (under say 2 feet in height) the effect is very much quicker and more thorough than with bigger clumps.

(2) Only the smallest pear is killed outright by the stronger solutions, which however cannot be thought of for financial reasons.

(3) No appreciable difference was noticed between spraying in the morning, and spraying in the evening, nor between hot and cold solutions.

(4) All prickly pear clumps (except those mentioned in (2) above die down in from 20 to 40 days depending on a large number of factors such as (*a*) size of the pear, (*b*) dryness of the locality, (*c*) dryness of the atmosphere, (*d*) strength of the solution ;

after dying down like that there seems to be a short interval and then come a number of new shoots. The size and strength of the pear appear to be the most important determining factors, and it is the thick strong clumps which seem to dry least and throw out new shoots quickest.

13. Other plots were experimented upon with solutions varying from 1 to 30 to 1 to 200 and always with similar results. Using a solution of 1 to 200, I have worked out the cost at about Rs. 5 per acre for poison only, but we must, of course, allow for uprooting and burning the pear after it has been poisoned.

I have had considerable experience of prickly pear removal in Central Coimbatore, and I invariably found that the greatest difficulty in eradicating this pest was to get it to dry sufficiently to secure a burn, and no matter how careful one was, there was enormous wastage of labour because unless the uprooted heaps were continuously being turned, and a torch put into them, they would begin to grow again and if in the meantime a shower of rain came down it was all up. It is just here that the usefulness of Atlas preservative comes in, for it does kill down the stuff to some extent, and does cause a fair proportion of the whole bulk to dry up, and, with this inflamable material available to begin with, burning is considerably facilitated.

Moreover, with a considerable proportion of the pear in a dead state, uprootal is made very easy.

It is, however, most important that the uprootal and burning be done at the correct time, *i.e.*, just after the pest has dried up and before it begins to throw up shoots.

This period varies from 5 weeks to 7 weeks.

A. M. C. LITTLEWOOD, I.F.S.

SOME ASPECTS OF THE EXPLOITATION OF BAMBOOS IN THE U. P.

The writer of this article is at present making the new Working Plan for the Lansdowne Division which is essentially a bamboo division and the following points have arisen during the process of the work.

The bamboos are all of the one species (*Dendrocalamus strictus*) and occupy the outer Himalayas (which are here mainly of sandstone), from about 1,000′ to 4,000′ elevation. They vary from pure crops of great density to a mere undergrowth in dense forest, and show very great variation in quality as well as in quantity, the best crops being on good deep soil on cool aspects with a fairly light overwood consisting of such light-crowned species as *bakli* (*Anogeissus latifolia*). They appear to suffer from drought and wind when a pure crop, and they are too strong light demanders to support heavy shade, hence it is being laid down in the Working Plan that, in areas to be managed for bamboos, the crop is to be treated in the same way as coppice with standards, the coppice (bamboo) to occupy two-thirds of the crown space, and the standards the remaining one-third. These figures are of course at present mere guess work, as very little is known about the silvicultural requirements of *Dendrocalamus strictus*.

The enemies of the bamboos here are numerous, and they may be classified as follows :—

(1) *Excessive grazing*.—This is controlled, as far as possible, by periodic closure, etc., but the experiments recorded in Troup's "Silviculture" adequately show, that where grazing is excessive, bamboo regeneration is practically stopped.

(2) *Wild elephants*.—There are far too numerous in this division and the damage they do is enormous. As it has been found impracticable to arrange for *kheddah* operations, it is being suggested that shooting licenses be issued until the number be reduced. No forest officer likes the idea of killing elephants, who are so useful to him in his work, but their numbers have become so excessive here, that something must be done to keep them in check. It is doubtful however if the issuing of shooting licenses will do much good, since nobody will take out an expensive license to shoot cow elephants and most of the wild elephants here are either cows or tuskless bulls (*maknas*).

(3) *Tame elephants*.—These and their *characuts* (elephant fodder-cutters) do tremendous damage in the neighbourhood of the camping grounds, and they must be forced to obey the bamboo cutting rules quoted later. Also bamboo fodder should ordinarily not be allowed to be cut in areas allotted to the bamboo

Working Circle, nor should tame elephants be allowed to graze in these areas during the rains.

(4) *The exploiting bamboo-cutter.*—This fiend does more damage than all the other enemies put together, and it is here that the crux of the matter lies.

(5) *Fire.*—Fire protection is of course absolutely essential.

The bamboos are worked on a 4 year rotation and the cutting rules of the Working Plan are as follows :—

(*a*) No cutting of clumps may be allowed in the year of their flowering, but they may be cut in the compartments for working after they have shed their seeds.

(*b*) No shoots of last rains may be cut.

(*c*) At least 3 healthy mature and fairly erect culms of not less than 10′ in height must be left in each clump, in addition to the shoots of the last rains.

(*d*) No digging or extraction of rhizomes may be allowed.

(*e*) Shoots may be cut only at a height of 6″ to 1′ above the ground except in cases of congested clumps where cutting must be done at the lowest possible point.

(*f*) The use of sharp implements is insisted upon in order to avoid tearing and splitting the stumps of the culms.

(*g*) Cutting may not be allowed in two operations.

The two most important rules are rules (*c*) and (*e*), (*c*) is absolutely necessary to preserve the vitality of the clump and (*e*) in order to prevent the clump from becoming so congested, as to become absolutely unworkable and useless, as is already the condition of an enormous number of clumps in this area. But in practice it has been found almost impossible, to induce or force the cutting coolies to obey these rules for the following reasons :—

(1) The bamboos are required in definite lengths for trade purposes, and the coolies have always been in the habit of bending the culm over, and cutting it off at the required length thus saving themselves two operations, and despite every effort on the part of the supervising forest guards, they revert to this practice the moment they are away from direct observation.

(2) The bamboo cutters are paid by piece work, according to the number of bamboos of definite length cut per day, and a quick worker can earn from Re. 1 to Rs. 2 per diem.

Hence, in order to cut a large number per day, the coolies cut practically every culm where they think they will escape observation, and cut them at any height from the ground according to the length available. In this way they frequently, either destroy clumps altogether, or by persistently cutting them high, soon ruin whole clumps by congestion.

All sorts of methods have been tried for stopping this but so far without success, and this article is written in the hope that someone can suggest a method which will be found effective in practice.

The following are the methods tried so far without success.

(1) *Fines on contractors.*—These are of little use, and soon reflect themselves in the prices obtained at auctions. Practically every contractor here expects to have to pay so much every year in fines, so that he regularly makes an allowance for fines when making his bid. In addition, the contractor himself has very little control over his men, and if he started fining them for not obeying the rules, he would soon be unable to obtain any labour at all.

(2) *More adequate supervision by forest guards.*—This is impracticable. The bamboos are scattered over very large areas, most of which are very steep mountain sides, and there are frequently hundreds of coolies working in one compartment at a time. The forest guards generally do their best, but they have other work to do, and the coolies will obey them only when they are actually present on the spot.

(3) *Selling bamboos in small lots.*—There is an idea of subdividing the areas for auction purposes and not selling two adjacent areas to the same contractor. This would certainly in theory make the cutting more under control, and would probably enable the responsibility to be fixed on definite gangs of coolies, but it would certainly cause a lot of trouble at the auctions, where the big contractors like to purchase large areas in one block, so as to facilitate their labour arrangements.

(4) *Forcing the contractors to go over the area again in order to cut all the stumps low.*—This may be feasible, although of course

the contractor will have to employ a special gang to do it, and the cost of such a gang will again be reflected in the auction prices. Also this will not remedy cases, where the required number of culms per clump have not been left. Rule (*g*) has been included in the cutting rules because contractors reply, when charged with cutting the clumps too high, that they will go over the area again before leaving to trim up the stumps—a thing which they never by any chance do in practice.

(5) *Making the contractor supply stump-moharrirs (stump-checkers).*—This has not yet been tried, but it is thought that it may possibly be of use.

(6) *Making the contractors work their areas progressively from side to side.*—This would certainly assist supervision, but it is difficult to enforce in practice.

(7) *Departmental cuttings.*—To those who have had the opportunity of seeing the excellent results obtained on the continent, by the quasi-departmental methods of extraction employed in such places as the forests of Bienne in Switzerland, the idea at once comes of employing those methods in India. But Indian conditions are different, and so is the Indian coolie. At Bienne, all felling is done departmentally, and the rough converted timber removed to the forest roads, where it is sold to contractors by its actual, and not estimated, volume. This method has numerous advantages such as—

(1) The fellings and extraction to the forest roads are carefully done by controlled labour.

(2) The regeneration is thus saved from unnecessary damage, and the trees are cut according to the cutting rules.

(3) The timber is sold by its actual and not estimated volume.

(4) It works excellently in actual practice as proved by long experience on the continent.

But, if this method were introduced here, it would, in all probability, be a very different story. Coolies would have to be paid at the same rates as they can earn by piece work, say Re. 1-8 per diem, and how many bamboos would they cut per day? Probably not more than one-half of the present numbers. No, there is no possible doubt but that the North Indian-hill coolie cannot

at present be satisfactorily employed in such work on daily labour, so that departmental extraction is also ruled out.

Hence, it would be admitted, that we are at present faced with a difficult problem. The condition of the bamboo crop is undoubtedly getting worse and worse every year, and up to the present no practical method has been discovered for effectively checking this.

F. W. CHAMPION, I.F.S.

FORESTRY IN GERMANY SINCE 1914.

BY C. A. SCHENCK, FORMER DIRECTOR, BILTMORE FOREST SCHOOL.

An American traversing Germany in 1914 and again in 1922 would not detect, indeed, any difference whatsoever between forestry in Germany then and forestry in Germany now. None of the German assets is less affected by the horrors of the last eight years than the German woods. Farming suffered badly from neglect while the men were in the army, further from lack of livestock, and notably from lack of fertilizers, without which crop-production is, with us, impossible. The railroads are run down and yield for various reasons a deficit in lieu of a revenue. The merchant marine is almost gone, under the Versailles pact. The colonies are lost. The potash industry has ceased to be a German monopoly ; so have the dye-works. The industries yield a wonderfully high rate of revenue expressed in paper marks and a miserable revenue expressed in gold. A 60 per cent dividend in paper is less than a 1 per cent. dividend in gold

Yet the woods stand intact. They have been saved, it seems by a very miracle, after yielding during the war, timber for trenches and guns and æroplanes: fuel when there was no coal; cotton substitutes for nitro-cellulose, for hygienic bandages, for sacking and packing, stable litter when there was no straw; turpentine and fats (beechnuts) when the foreign importation had ceased; and indeed leaf food for horses and for cattle, though on an insufficient scale.

Indeed, while some 10 million men were wearing the uniform, there were not hands enough left to cut as much as the regular annual "sustained yield."

Forest property has proven to be the best, the safest, the most remunerative investment.

To-day though there are no building activities, the demand for timber is enormous, so is the call for pulp wood, for fuel wood, and even for charcoal. Oak tanbark, which was a drug on the market in 1914, fetches a price which, even translated into gold marks, is satisfactory.

Why all that? Prior to the war, one-third of the timber used in Germany was imported. To-day Germany is unable to pay for any importations. Prior to the war there was an abundance of coal. To-day with the coal of Sarre region and of parts of Silesia lost, with 2 million tons of coal due monthly under the Versailles pact, to the victors, there is a general lack of coal, so much so, that many industries are running on wood instead of running on coal.

Nevertheless, in the State forests, in the communal forests, and in the entailed forests of Germany, the annual cut has not increased or else has been increased so little as to keep the demand for wood goods far above the supply of wood goods.

Alas! If the forest owners, controlling the market by concerted action and by open combinations in restraint of trade, were confronted by a Sherman anti-trust law, all of them would have to go to Sing Sing. What is a "sustained yield," indeed, unless it be, when generally adopted, a combination in restraint of trade?

Verily I say unto you, there will not be any American forestry unless the Sherman anti-trust law be altered in favour of

sane forest conservatism. *Unlimited competition* in the face of *limited* supplies of timber, spells economic suicide.

True, a sustained yield is not generally adopted in Germany. The owners of small woodlots do not stick to it; and these owners, after a period of non-cutting during the war are overcutting their holdings to-day, tempted by high prices, and forced to make money by high taxes on all and on everything.

Forest Policy.— In forestry instruction, the tendency is towards concentration of effort. Germany is now too poor to maintain, on a high level, its institutes of forest learning. Thus it happened, *e.g.*, that the Universities of Tubingen and the Karlsrhue-Tech have combined their forest schools in the University of Freiburg; that the old Prussian forest school at Muenden has been abandoned, while the time-honoured institute at Tharandt in Saxony is apt to become attached to either the University of Leipzig or else the Dresden-Tech. All of the institutes are short of funds. And forest research work is badly handicapped.

Under the new democratic constitution, the family entails were to be dissolved. Yet it was found that a dissolution of the forest entails was or would be a bad blow on forest conservation. Thus nothing has been done so far. Organisations similar to joint stock companies may be the result.

In the various State diets, to still the urgent call for new farming lands and for their products (over one-third of Germany's food must be imported), the demand has been made to convert forest land, wheresoever it stocks on tillable soil, into farm-land. In this connection little progress has been made. On the one hand, there is the resistance to such demands of all foresters in a united front; on the other hand by such inroads, the normal gradations of age-classes in the woods, obtained by decades of unswerving effort, would be thrown overboard. And, in addition, the forests in the proximity of the cities, where the call for new land is particularly pressing, are used to such an extent as parks for the whole people (not merely for the owners of automobiles) that, in every given case of proposed deforestation, the "noes" have it, and not the "yesses." Also, some conversions of woodland into farm-land, undertaken on a large scale by the authority of the State have proven to be utter failures financially.

Nevertheless it can be stated that there is as much deforestation now, in order to gain farm and gardens, as there was afforestation prior to the war, in order to convert remunerative farm-land into forest. Both kinds of mutations were and are significant expressed in percentages of the total area of woodlands.

So as to check indiscriminate cutting of fuel wood on farm woodlots, some States have adopted the rule of *distributing* all the wood cut, *per capita* of the population, at fixed prices, and forbidding any free sale of fuelwood. Other States, so as to prevent the fuelwood prices from going skyward, have forbidden any sale of fuelwood at public auction. Such measures of coercion, temporary in their effects at best, are being gradually abandoned, or else have already been discontinued.

Under the Versailles treaty large quantities of prime timber (also ties and poles) must be furnished to France, Italy and Belgium. Little has been done. There are several reasons. The prices stipulated are so low, that the central government cannot obtain anything at them; and the German Government as such does not own one acre of woodlands in *National* forests, all government forests being *State* forests. Further the French and the Belgian timber merchants do not want to lose their trade. Thus it happens that all the mills in Western Germany are busy with French and Belgian private orders; while the official representatives of the various sides cannot—good will or bad will—obtain the results desired.

Forest Utilisation.—In the methods of logging and lumbering there is nothing new to be related. The high prices of lumber have induced many a novice to engage in milling; invariably with dastardly results for everyone, except for the makers of saw-mill machinery. In saw-mill machinery there is no innovation. The vertical gangsaw, with blades of 26 or 28 gauge, and the horizontal straight saw (cutting on either movement of the saw), with its wonderfully smooth and fine kerf, are ruling supreme, hereafter as heretofore. To many a mill, in the softwood region, a small groundwood pulp plant has been attached, to consume slabs anp refuse with satisfactory results, where there is water-power. The saw-mills are running at the double quick, in three shifts of 8 hours

spurred by urgent orders. I need not tell the readers of this journal that, in Germany, the owner of a forest is but in rare cases also the owner of a saw-mill. Logs, pulpwood, fuelwood, and tanbark are sold at public auction to the highest bidder. If a minimum price pre-arranged among the owners' associations (States, communities, church-funds, entail), fails to be obtained, the auction is not approved by the owner, under the very conditions read prior to bidding, and a new auction is ordered. Lo, how the good public in the good U. S. A. would howl if it were exposed to such cut-throat methods! Yet, when the public itself, as owner of the main body of the woodlands, is the beneficiary of high prices, not much harm is being done.

In forest transportation the autotruck has made considerable advance. All transportation, from the woods to the railroad, goes, of course, over permanent macadam forest roads in which lies, in my opinion, the very secret of all forest conservation in Central Europe. Transfer the macadams spanning and riddling the German Black Forest bodily to the Adirondacks, and no owner would continue, in the Adirondacks, any indiscriminate cutting. Conservative lumbering would be, at once, more remunerative than destructive lumbering, particularly so, if the main macadams are maintained at public expense. Permanent forestry is, *de facto*, a problem of permanent arteries of transportation.

Tanbark and chestnut wood and oak wood are used, in 1922, on a scale absolutely new in the German tanneries. They cannot pay for quebracho, for myrobalans, and for catechu; the home-grown stuff *must* answer.

I have referred to bandages of all sorts made, to-day and since the blockade, of wood cellulose instead of cotton. Every drug store is offering them. I might also mention that real progress has been made, in the use of wood by the viscose process, in the manufacture of spinnable and weaveable threads. Artificial silk has, of course, come to stay, its qualities having been wonderfully improved by the United "Glanzstoff fabriken" at Elberfeld. The German dynamite trust, forced to find a peaceful use for its former bellicose energies, has placed on the market, more recently,

a woodwool styled "Vistra-wool" which is said to be a fair substitute for cotton. Is King Cotton going to be deposed by King Wood?

Silviculture.—Silvicultural fashions have been changing in Germany during the last 50 years almost as rapidly as have ladies' fashions on Broadway. None came to stay. To-day the newest fad is the "Dauerwald" or "Timber-perpetuation," a system or a mood which strictly avoids clear-cutting even on minute units of area, which discards planting of seedlings or of seeds, and allows nature to do all the work. Another novelty is the regeneration from self-sown seeds coincident to cuts made wedge-shape, successively. And there may be other panaceas to solve all problems of regeneration at one stroke.

In thinnings, the "par le haut" begins to prevail over the variety "par le bas."

The wages have risen so tremendously that plantations of pine costing, in 1914, 150 gold marks per hectare, equal to $15 per acre, entail an outlay to-day of 5,000 paper marks per hectare, equal to some $17 per acre! A tremendous difference, indeed! Yet tremendous only from the German standpoint. As a consequence fewer seedlings are being used per acre, and reinforcing, that old bugbear is being intensified.

Among the American species planted in Germany, red oak and white pine, the latter in spite of the ravages of the blister rust continue to lead. There is also a heavy demand for Douglas fir, sawlogs of which are beginning to be offered on the market, from German-grown stock.

To judge from the American literature, the blister rust is not so bad with us as it is in the U. S. A. There is no wild currant in Germany! One of my friends tries to raise a rustless strain or variety of white pine, another claims that his natural seed regeneration of *strobus* are immune while his plantations are being handicapped.

Forest Finance.—Forest finance as a branch of Science is dead; the war has killed it. Poor Max, Pressler, poor Gustav Heyer, and poor Fred Judeich have all lived in vain. All those finely-spun calculations at compound interest by which the age of maturity, the proper level of the timber investments, the value

of immature woodlots, and what not, were to be determined, have proven to be futile. One fact is made plain: In the long run of events the most conservative variety of forestry has proven to be the most remunerative variety of forestry. And Saxony, once the admired leader in forest finance, with its emphasis laid on spruce as the main money-producer, on short rotations, on rapid planting after clean sweeps, Saxony has become the laughing stock of the other States of the German Union.—[*Journal of Forestry, Vol. XX, No. 7.*]

HOW SAP RISES IN PLANTS.

REMARKABLE DISCOVERIES.

Sir Jagadis Bose is famous for his investigations into the physiology of plant life. He is about to publish another work upon that subject, and has given an indication of its contents in a newspaper contribution, which is already attracting much attention among scientists. It is, of course, commonly known that trees and plants obtain their inorganic food material from dissolved substances in the soil. They suck up the water by the root, and the moisture is transpired into the air by the leaves. The quantity of water thus raised is much larger than most people are aware of. A big tree, for instance, will get rid of a hundred pounds a day. The energy required for raising this weight of water is very great. How the moisture is raised upwards has been a secret of nature for all time. Sir Jagadis Bose has now unravelled that mystery. It has long been disputed whether the sap is lifted by living cells, or by suctional force, developed by physical evaporation of the leaves. As the result of many experiments in the professor's research institute at Calcutta, it has now been established that the rising of the sap is due to the activity of living cells. In the course of these experiments the use of specially constructed instruments showed that under favourable circumstances, sap will rise at the rate of a hundred feet per hour. Such a velocity of ascent was deemed to preclude the theory of capillary action or atmospheric pressure. By exploring every outside skin to the pith inside, while the plant was still functioning, Professor Bose was able to discover that the pumping process was the work of

living organism. Professor Bose devised an electric probe, which he attached to a sensitive galvanometer. This instrument gave surprising results. It showed that cells in the active layer of a tree work with a throbbing pulsation, alternating expanding and contracting, absorbing water from below and expelling it upwards. The period of a single pulsation in the most effective experiments was estimated at 14 seconds. These cells are confined to the cortical sheath, which extends throughout the whole length of every tree. There is also a certain limited amount of water storage, for what one may call reserve purposes, in the wood vessels of the tree. This storage is also supplied by the same pulsations. Professor Bose's experiments establish the fact of a wonderful similarity in heart-beat records of animals and plants. In the animal, there is an increasing heart-beat under a rising temperature ; the pulse beat of a plant is similarly increased under similar conditions. There is a converse effect under a low temperature. This explains the drooping of leaves under a frost. It is also shown that the plant, like the animal, contracts under a shock, for both plants and animals have a well-devised nervous system. Drugs affect the animal and the plant alike. Professor Bose declares there is no characteristic action in the highest animal that has not a counterpart in the simpler life of the plant.—[*The Australian Forestry Journal.*]

THE POSSIBILITIES OF AERIAL PHOTOGRAPHY.

The making of photographs from aircraft is rapidly assuming importance in all sorts of engineering work, and to a less extent in advertising. Photographs of industrial plants, like the above, give a far better idea of the layout and appearance of a mill than any formal perspective drawing can possibly do. Vertical photographs have all the advantages of line maps and blue prints and give infinitely more information, and are much more intelligible to persons unaccustomed to reading maps and drawings. Nothing escapes the eye of the camera, and a photograph can be studied in the office at leisure and all the information it contains extracted. Insurance companies have found that they can see forbidden piles of rubbish, old boxes, etc., in backyards, which have escaped

their inspectors, when the premises are photographed from the air. Recently a power company wanted to locate a right-of-way for a transmission line. They had the proposed routes photographed from the air, the engineers picked out the one they wanted, the property lines showed on the photos, and the owners were looked up in the county records. Before any engineering parties had been on the ground, the owners were looked up and the properties purchased, before anyone knew that any power line was contemplated.

Aerial photos of the forest are equally valuable. With the old method of timber cruising, strips are run through the forest at intervals of one-half mile to a mile, and all the trees estimated on a strip 66 feet wide. The width of this strip is estimated by eye, and wherever its centre line crosses a lake, swamp or burn, a note is made at the beginning and end of such feature, and also at the beginning and end of each timber type. The boundaries of types and lakes, swamps, burns, etc., are sketched in from these notes giving the areas. From the strips the average amount of timber per acre is calculated, and applied to the various types. In this way the usual percentage of the total area estimated is two-and-one-half. Sources of error are the eye estimate of the width of the strip and the areas of the various types, burns, lakes, swamps, etc., which are sketched in. Then, too, the small amount of country actually covered. With aerial photos the actual area of each type is measured with a reasonable degree of accuracy, the boundaries of types are more accurately determined than is possible on the ground, areas burnt, windthrown, killed by insects, swamps, etc., can be accurately measured. The amount of timber per acre can be estimated from the pictures by comparing them with areas already studied in detail, and if more accurate estimates are required, a small amount of ground work can be done to check up. One hundred per cent of the area is covered, and the time is only a small fraction of that required to do ground work. The methods are out of the experimental stage, and have been successful in important actual work.—[*Canadian Forestry Magazine, December 1922.*]

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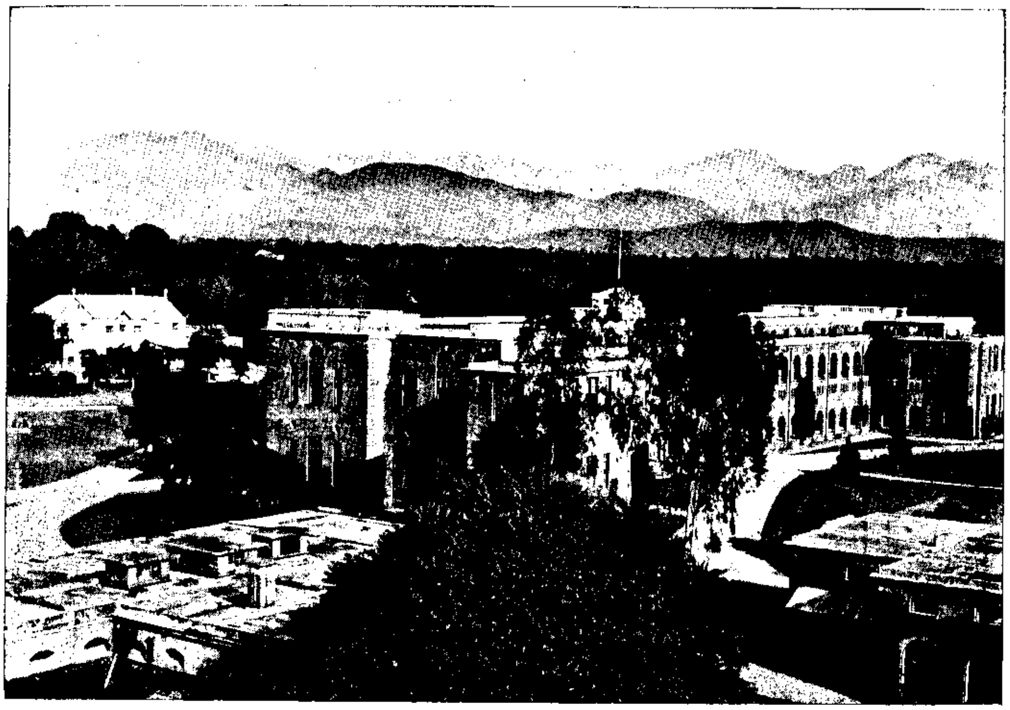
A VISIT TO THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

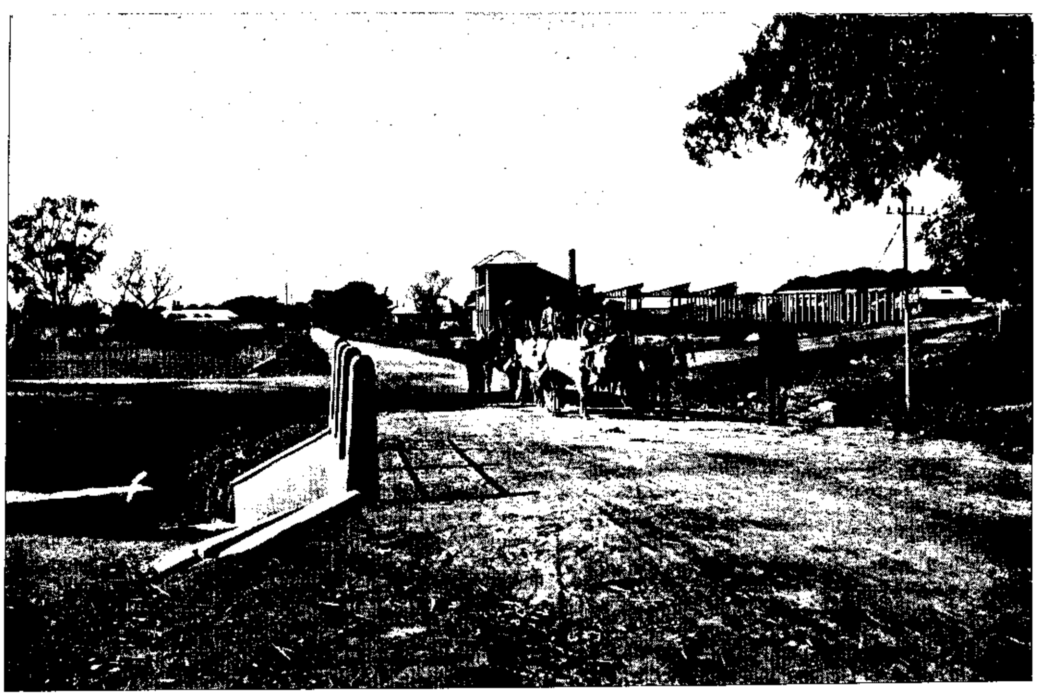
PART I.

Introduction.—The following note has been written by a Forest Officer visiting Dehra Dun for the first time, and records impressions of what he saw and heard, in connection with the Forest Research Institute, during the first few weeks of his visit. In view of the necessity for retrenchment, and the doubt which exists as to the Sanctioned Scheme of Development being allowed to go through, an attempt has been made below to discuss the matter in popular style, and to set forward the arguments in favour of development from the point of view of a Forest Officer, who has never before had anything to do with research work, but who is now beginning to realise something of its value.

First impressions of a Newcomer.—To a newcomer the scheme of development in connection with the Imperial Forest Research



General view of the present Forest Research Institute.



Institute at Dehra Dun is somewhat awe-inspiring. One sees here one's dreams of Forest Development, not only taking shape, but doing so on a scale far grander than that of which one had ever dreamt. In fact one almost feels, in these days of axes, that there must be something wrong when the President of the Institute shows one over "The New Site," and says that the spacious buildings, which are now being fitted with all kinds of expensive machinery, are only the workshops of the Economic Branch. No residential quarters have yet been started nor has anything been done in connection with the erection of the Main Building, which will contain the offices of the President and the Heads of Research Branches and the Museums. This building alone is planned to be twelve hundred feet long. As a matter of fact the Inchcape "Axe" *has* cast its shadow before it, for no new construction is being permitted for the present, though the whole scheme, estimated to cost some fifty lakhs, has long ago received the sanction of the Secretary of State.

A comparison of the areas of The New Site (about 1,300 acres), and of the present Institute (about 26 acres) is enough to take a newcomer's breath away; especially when he is told that the present Institute is still quite a baby, about eight years old. It is just this very fact, however, that forms the main argument in favour of taking up such a large area. The present Institute is already badly overcrowded. Four different schemes for extending the present site have been considered but the most that any of them would yield was another 26 acres. As the Economic Branch alone required at least 72 acres for its sanctioned Workshops and Mills, the question of extending the present site had to be dropped. The President was determined that the mistake of selecting too small an area should not be repeated. In his opinion, if anyone has the duty of selecting a site for a new scheme or business, he should first calculate the amount of space required, then add to it the space he thinks will be required for future expansion, and then multiply that result by three at the very least.

Value of a Visit to Dehra Dun.—Another thing that impresses a newcomer very forcibly is that, the best answer to

the natural question "why should so much money be spent on developing the Forest Research Institute?" is, "visit Dehra Dun and see for yourself!" Even a newcomer can see that the necessity is great. A visit to Dehra Dun reveals the congested state of the present Institute, and the difficulty of extending the present site. The visit does more, it somehow impresses the visitor, far better than any description could do, with the practical value of the work that the Research officers are carrying out. These officers are very keen to show Forest Officers, and others interested in forest matters, round both the present Institute and the New Site. They believe that every Forest Officer should visit Dehra Dun. Such visits not only have a valuable educative effect, but help forward Research work, both in the Forest and at the Institute, because of the better understanding and co-operation which result from them.

The present Research Institute.—Before passing on to the description of the New Site, a few remarks about the present Institute are necessary. It is situated in Dehra Dun Cantonment in pleasant park-like grounds, at a distance of about a mile from the Rangers' College and the President's residence, which is known as "Forest Park." The Provincial Classes, however, have their quarters and lecture rooms, and their football and hockey ground in the grounds of the Research Institute. The present Rangers' College served as Research Institute and College combined, as recently as eight years ago. It is now too small as a Rangers' College.

Organisation.—The President is the controlling officer both for Forest Research and for Forest Education. The Research work is divided into five branches, controlled respectively by the following officers :—

The Forest Botanist,
The Forest Economist,
The Forest Chemist,
The Silviculturist, and
The Forest Entomologist.

Each of these officers is assisted by one or more Imperial or Provincial service officers.

The Economic Branch is further sub-divided into the following Sections :—

Minor Forest Products,
Timber Testing,
Timber Seasoning,
Wood Technology, and
Paper Pulp.

The section of Minor Forest Products is in charge of an Imperial Service Forest Officer. The remaining Sections are run by specialists engaged on short term contracts. Their staffs are also engaged on a temporary basis at present. There is, in addition to these Sections, a Wood Workshop in charge of a Superintendent, engaged in England, who is assisted by a European Carpenter, also recruited from home. At the New Site provision has been made for two more Sections, *viz.*, Timber Preservation and Veneering; there will be an iron workshop in addition.

Buildings.—There are only three residential buildings at the present Institute. One is occupied by the Forest Botanist, one by the House Tutor in charge of the Provincial students, and one is reserved as a chummery for bachelors and "grass-widowers."

The Main Building is double storeyed. On the top floor the Silviculturist and Forest Entomologist have their offices and museums. The officer in charge of the Paper Pulp Section also has his office upstairs. On the lower floor there are the Timber and the Minor Forest Products Museums, the Library and offices for the Forest Economist and his staff.

The Forest Botanist's office, the Herbarium and the Photographer's Dark-rooms and Studio are situated in a separate building to the north of the Main Building.

To the south-east of the Main Building are three small buildings—the Insectary (where forest insect pests are reared), the Forest Entomologist's laboratory and a Students' Laboratory.

To the south-west of the Main Building is an irregular line of buildings. First comes a small Timber Testing Labora-

tory; then a larger building, the Forest Chemist's Laboratory and office, then a small Gas Factory, and then the Distillation Plant. Last of all two small sheds, one of which is the Wood Workshop, and the other the European Carpenter's Workshop. At the farther end of the Wood Workshop a temporary kiln has been erected for demonstration purposes, which will be dismantled shortly, after a test run of *Dalbergia Sissoo* planks and felloes from Jubbulpore has been carried out. The Paper Pulp Specialist has a small Laboratory in the same building as the Forest Chemist.

The officers of the Economist's Branch are extremely badly off for room. Although the Timber Testing Officer has only four Testing Machines in his Laboratory there is literally no room in it to move. The Seasoning Specialist has to borrow odd corners from other officers for carrying out his laboratory experiments. The Paper Pulp Specialist has none too much room but has to put up with the Seasoning Officer's Laboratory Kiln. The Wood Workshop is ridiculously overcrowded. Apart from the lack of space for storing lumber, there is barely room in it for the various machines, and the carpenters are practically sitting on top of each other. This Shop contains one small Circular Saw-Bench, one Small Band-Saw, a Planing Machine, a Vertical Spindle Moulder, two Drilling Machines and a Saw-sharpening Machine.

NECESSITY FOR THE NEW SITE SCHEME.

The Need for Expansion.—In view of what has been said above it is clear that the needs of the Economic Branch alone necessitated the selection of a new site for the Research Institute as there was no possibility of extending the present one. The fact that Forest Research on a scale approaching commercial conditions is about to be undertaken, means that the Economic Branch will alone occupy an area about three times the size of the present Institute. And, as the remaining Branches of Research had reached the limit of expansion possible in their present buildings, and could do with a good deal of additional space, it was decided that the whole Institute should move to

a fresh site. The question of moving the Institute to some more convenient and central station, such as Jubbulpore, was considered, but the advantages which Dehra Dun offered in the way of climatic considerations and the fact that the Institute was already there, and could easily be visited by commercial people journeying to and from Mussoorie, led to the retention of the Institute at Dehra Dun. As the New Site Scheme, involving the transfer of the whole Institute and the Provincial Classes, to a site two miles further out from Dehra Dun, was sanctioned at a time of prosperity, when exchange was high and money was easy to obtain, the question as to whether the expenditure which the complete move entailed was justifiable or not was barely given the consideration which it is now receiving. The opinion is now frequently expressed that only the Economic Branch of the Research Institute should move to the New Site, and that the remaining branches and the museums should remain where they are till the financial situation improves. The necessity for the complete move will naturally increase as time goes by. There are, however, two other aspects of the New Site Scheme which may be urged in favour of an early move of the whole Institute to its new home. These are the questions of Residential quarters and of Forest Education.

Residential Quarters.—Research Officers and Instructors experience, at present, considerable difficulty in the matter of obtaining convenient bungalow accommodation. The present Institute only has three bungalows attached to it. Most officers have to live miles away from their work, either in expensive bungalows or in hotels. The New Site provides thirty-four bungalows for the President and controlling staff, and quarters for all others who will be connected with the future Institute. The benefits to be derived from such a concentration of bungalows and quarters may be appreciated without any special mention.

Forest Education.—The question of Forest Education is, at present, very much in the melting pot. It is very likely that Rangers' College will be completely provincialised. If this happens it is proposed that the present Rangers' College should be sold, as the land is extremely valuable, and that the present

Research Institute should be handed over to the Government of the United Provinces as their Rangers' College. The Provincial Classes will move with the Institute to the New Site. The action of the Legislative Council, in deciding that even the Imperial Forest recruits should receive their training at Dehra Dun, even though such a course will be much more expensive than the present arrangement of training them in Europe, is, in itself, a justification in part for the New Site Scheme, which has allowed ample room for unforeseen expansion of this kind.

Description of the New Site.—The site is three miles long and, on an average, three quarters of a mile wide. It runs practically East and West, being bounded on the South by the Chakrata Road, and on the North by a wide and deep nulla which runs down from the heights of Mussoorie towering above to the North-East. The site is situated in beautiful open country with fields all around. The highest ground on the site is within a few feet of the nulla referred to above, and forms a long ridge immediately overlooking it. The slope of the ground is precipitous towards the nulla, but very gentle in the direction of the Chakrata Road On this ridge, it is hoped, will be built the bungalows for Research Officers and Instructors. The view from here is perfectly wonderful. Mussoorie seems only a step. The Chakrata Hills, some distance away to the North, are particularly picturesque, and the rugged Siwaliks, circling the Dun towards the South and West, complete the picture. This must be one of the finest building sites in India : one cannot help congratulating the officers who were responsible for its selection.

The Main Building will be three and a half times as long as the present Main Building, and will also be on the ridge, but set forward a little from the line of bungalows. The Workshops, Kilns, Mills and Godowns, of the Economic Branch, which are the only buildings which have so far been built, lie in the Eastern corner of the New Site, a little to the East of the site for the Main Building. The bungalows for the officers of the Economic Branch will occupy the Eastern end of the ridge, not far from the scene of their work. Quarters for the subordinate staff and for labour will be lower down, nearer the Chakrata Road. The Main

Entrance will be from the Chakrata Road, by a fine wide avenue leading straight up to the Main Building. The approach to the Economic Branch lies through a tea garden, the shelter trees of which (chiefly *Albizzia procera*) are so closely grown that the road looks like a delightful forest avenue. By this road the eastern end of the New Site is not quite two miles from the present Institute. The following is a description of the buildings of the Economic Branch which have been actually built.

THE ECONOMIC BRANCH.

Grouping of the Sections.—The Sections of the Economic Branch have been grouped in three Units, as follows:—

Unit I.—Sawmill.
Iron Workshop.

Unit II.—Seasoning.
Pulp and Paper.
Preservation.

Unit III.—Wood Workshop.
Veneer Mill.
Timber Testing.
Minor Forest Products.

In addition to the buildings connected with the above Sections, the only other buildings which have been built are an Electric Transforming Station and Quarters for a Store-keeper.

Layout.—The three Units are side by side, Unit I lying in the eastern corner of the site, Unit II next to it, and Unit III nearest the Main Building. Unit I consists of two blocks of buildings only—the Sawmill and the Iron Workshop. Unit II consists of four blocks—an office building for the Sectional Officers and their staffs, the Seasoning Plant, the Paper Mill and Preservation Plant with the Boiler Room and, finally, a large Godown. Unit III consists of three blocks—an office building like that of Unit II, one large block containing all four sections and a large godown similar to that of Unit II. The three sections of Unit II will require steam in addition to electric power. The other

Units will be run by electric power only, except that the Veneer Mill will have a small boiler for steaming logs.

Communications.—The three units will be connected up by tram-lines for the movement of material. There will also be metalled roads connecting the various parts of the branch, some of which will be main thoroughfares. Hand controlled trucks will be used on the tram-lines.

To facilitate the handling of material indoors the Sawmill, the Paper Mill and all the Sections of Unit III will be fitted with gantry cranes. Some of these are already in position. No rails are provided inside the five kilns, as they will be loaded and unloaded by hand. The lumber has to be handled in any case when it comes from the Sawmill, for sorting and grading purposes, so that kiln trucks would have offered no particular advantage.

Constructions.—Mr. F. T. Jones of the P. W. D. is in charge of all construction work, but the erection and fitting of the machinery is being done by Mr. Low, very ably assisted by Mr. Ram Das, both of the P. W. D. The various Sectional Officers exercise technical supervision over the fitting work, which necessitates their visiting the New Site almost every day. Up to the present the Iron Workshop and one Tiemann Kiln have been completely fitted, and the Paper and Pulp Mill, the Preservation Plant, the the Veneer Mill, The Timber Testing Plant and the Sawmill Plant are all being put down. It is hoped that the plant of all sections will be completely installed by the end of next April.

The walls of all the buildings are of red brick, strengthened where necessary by reinforced concrete pillars. The roofs are all of corrugated iron, which is being covered with creosoted pine shingles. A more detailed description of the plant is given below.

PLANT.

The Machine Shop.—This is fitted in up-to-date fashion, and is now in actual working as the electric power, which should have been supplied in October, has recently been connected in by the Mussoorie Municipality. The machines include a drilling machine,

a lathe, a threading machine, various tool sharpening machines and a first-class shaping and surfacing machine. Attached is a blacksmith's forge.

The Samwill is fed by an electric gantry crane nearly three hundred feet long. A log pond will be constructed between the uprights of the gantry for most of its length, so that logs, on arrival at the Mill, will be immediately placed under water safe from climatic and insect dangers. These logs will not need further handling when their turn comes to enter the Sawmill, as they will be picked up out of the water by the gantry and placed on the top of a log roll. At the end of the log roll will be the log carrier for the breaking down saw, which will be of the circular type. The log will be carried backwards and forwards on the carrier till completely converted. The cut slab will pass on to the edger, where it will be cut to the required width in one operation, and will pass straight on to the cross cut saw (pendulum type) where it will be cut to the required length. Thus there will be in all only three benches. The material will pass through the Mill with the minimum amount of handling. From the Sawmill the lumber will pass, by tram-line, either to the Seasoning Kilns or to the Godown of Unit II.

The Pulp and Paper Mill.—This is an up-to-date plant, which will permit of various kinds of raw material being treated in different ways on a semi-commercial scale. The digesters and diffusers of the Pulp Mill have been erected, and impress one by their massive proportions. The whole plant of both parts of this Mill cost about £12,000.

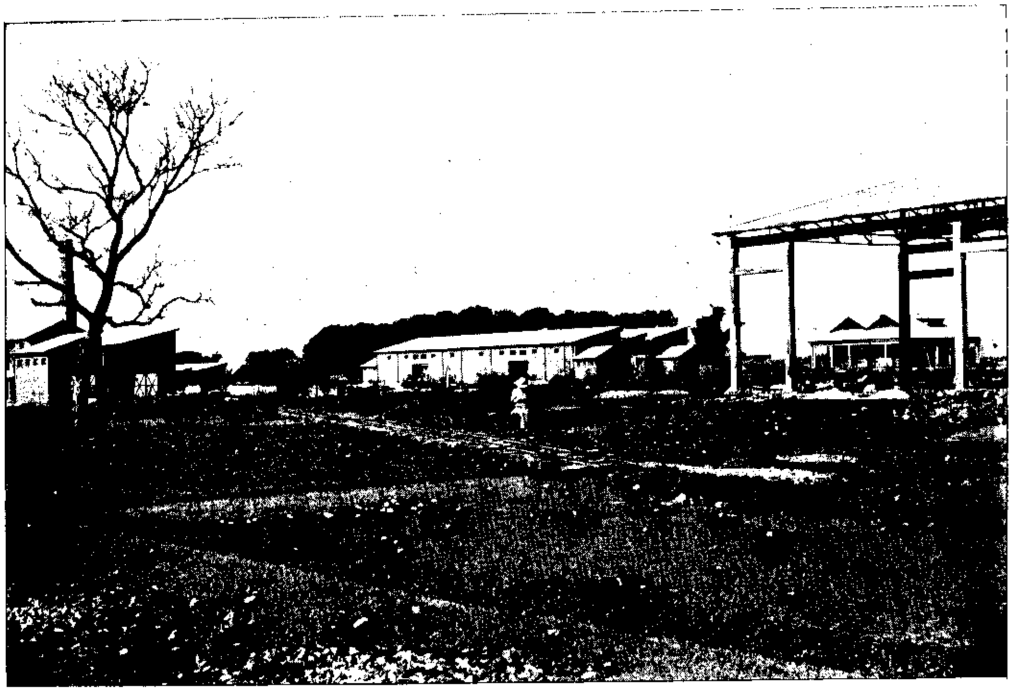
The Preservation Plant.—This will be a Pressure Plant. There will be two storage tanks (for creosote and earth oil respectively), a mixing tank, an impregnation cylinder, capable of holding broad gauge sleepers, two pressure vessels and the necessary pressure and vacuum pumps. The mixture of the treating fluid, and the temperature and pressure inside the cylinder will be capable of variation at will. The plant is now being installed, under the technical supervision of the Forest Economist himself, as there is, at present, no Preservation Officer, though the appointment is one that has been sanctioned.

Offices of Seasoning, Preservation and Paper and Pulp Sections.

Tiemann Seasoning Kilns

Boiler House and Paper and Pulp Mill.

View of part of the Economic Branch, new Forest Research Institute—looking W.



Photos. by R. P. Dalley, I.F.S.

Boiler House and Paper and Pulp Mill.

Godowns

Corner of Sawmill

Continuation of the above view.

The Seasoning Kilns are all of the Compartment, and not of the Progressive type. There are three Tiemann Water Spray Kilns of American manufacture, and two Sturtevant Kilns of English make. The former is the kind chiefly used by the American Forest Service in their Research work, and has also been adapted for commercial work in connection with the seasoning of refractory timbers. The latter kind has been successfully used at the Royal Air Force Factory at Farnborough. The two kinds of kilns represent two different principles in kiln drying, both as regards the means of circulating the air and the method by which the humidity is controlled.

In the *Tiemann Kiln* the circulation of the air is brought about by differences of air-pressure on the 'entering' and 'leaving air' portions of the kiln. The difference in air-pressure is brought about by means of fine sprays of cold water, which shoot downwards from a line of spray nozzles into a narrow 'spray chamber' situated along one or both sides of the kiln. (In the kilns at the New Site, which are of a small and narrow type, there is only one spray chamber in each kiln. In commercial kilns, *e. g.*, the ones at the Wood Working Institute at Bareilly, there are two) These sprays, by cooling the air and carrying it downwards to the bottom of the spray chamber, cause the air above to sink, or be drawn down on the leaving air side of the pile, or stack of timber. The entering hot air rises up the other side of the 'pile,' and passes downwards through it owing to the action of the sprays and also to the cooling effect of the drying timber. The moisture absorbed by the air as it passes through the pile is condensed by the sprays. The air is recirculated through the pile after it leaves the bottom of the spray chamber. It naturally leaves the spray chamber in a saturated condition. By passing first through some wooden baffles the spray or mist is mostly removed. It then passes over the 'Heating Coil,' four coils containing from four to fourteen pipes passing the full length of the kiln, under the pile. These coils may be independently filled with either high or low pressure steam, according to the temperature required. As the saturated air passes over the heating coils it becomes heated, and therefore no longer remains saturated. The actual percentage of the relative

humidity of the 'entering air' can be very exactly controlled by varying the temperature of the water in the sprays. The warmer the water in the sprays, the warmer will the saturated air be, and the higher will the relative humidity of the heated air be after it passes through the heating coils into the kiln above. The amount of steam that passes into the heating coils can be regulated by means of a thermostat, so that the temperature of the entering air is kept constant automatically. The temperature of the water passing into the water-spray line can also be kept constant automatically by means of a 'Water Mixture,' which takes in both hot and cold water in just the right proportion, no matter how much their temperatures vary, so as always to give out water of the correct temperature for the sprays, with the result that the humidity of the entering air is also automatically controlled.

In the *Sturtevant Kiln* the heated air is forced through the timber pile by means of a fan or blower. In the type being fitted at the New Site the side walls of the kilns are hollow, and contain numerous vents. The fans blow air through radiators, containing heated steam coils. This heated air then passes into the hollow wall on one side of the kiln. Thence it passes into and through the timber pile, and is drawn out into the hollow wall on the other side through the vents. This exhaust air is sucked out of the hollow wall by the action of the fan, which recirculates it, thus causing economy in heating. If the recirculated air is too moist, fresh air is added to it before it passes over the radiators again. If there is not sufficient humidity in the entering air this is supplied by means of a live steam spray pipe placed inside the kiln. In this type of kiln the humidity cannot be controlled automatically, but has to be watched and controlled as required. The temperature of the entering air can be controlled automatically by means of a thermostat, which regulates the quantity of steam supplied to the radiators in such a way that the temperature of the air is maintained at the required degree of heating. No heating coils are being installed near the ceilings of the Sturtevant Kilns to prevent condensation drip from the roof, as has been done in the Tiemann Kiln, as the Sturtevant Co. do not think they will be required.

Of the two types of Kilns, the Tiemann will be the more useful for Research purposes, for which it is necessary that temperature and humidity conditions should be both accurate as well as constant, not only on the entering air side, but, as far as possible, in every corner of the kiln.

The Minor Forest Products Laboratory will be the scene of work which is to some extent done, at present, by the Forest Chemist. There will also be Fibre Retting Machines and appliances for testing various Tanning materials.

The Veneer Mill will consist of a small up-to-date Veneer Cutter and the necessary plant for steaming logs. The work will be of a purely experimental nature. Tests in the manufacture of three and five-ply wood as well as of the different adhesives, will also be carried out. The necessary Veneer drying plant will also be installed.

The Timber Testing Laboratory will contain fifteen or sixteen Testing Machines, capable of testing both small and large pieces of wood. The present Laboratory accommodates only four testing machines, of which three only can be worked, owing to the lack of electric power. The work of this branch will be extremely important. It requires thousands of individual tests to complete an inquiry into the properties of a single species so far as strength is concerned. Apart from the variations in strength due to locality, numerous others have to be taken into consideration, such as the weight of the specimen, its moisture content, its position in the tree (*i.e.*, height, also distance from the pith) and the rate of growth. The variations caused by defects also have to be considered, though the first tests are carried out with clear specimens only. Normally seven different strength tests are carried out for each kind of timber. These are—

1. Static bending.
2. Impact bending.
3. Compression parallel to grain.
4. Compression perpendicular to grain.
5. Hardness. (Tangential and radial).
6. Shearing. („ „ „).
7. Tension. („ „ „).

Other special tests can also be carried out, *e.g.*, the test for Spike pull when a timber is being tested for Railway Sleeper work.

The Wood Workshop will include all the machines at the present Wood Workshop. There will also be a four square cutter which will edge, surface and mould all in one operation. From a Research point of view a Wood Workshop is essential. Apart from the work involved in the preparation of true planed specimens for the Timber Testing Laboratory, there will be a great deal of experimental work in connection with the behaviour of different species in different sizes and thicknesses, under different methods of treatment.

The above description of the Forest Research Institute (present and future) aims at showing that the sanctioned scheme of expansion necessitated a "New Site." Very little attempt has been made to justify the sanctioned scheme, as the value of progress in Forest Research and Forest Education has been taken for granted. In view of the possible action of the Inchcape Committee, this aspect of the question will be discussed below.

THE VALUE OF FOREST RESEARCH AND EDUCATION FROM A FINANCIAL POINT OF VIEW.

The cost of Research.—In view of the fact that the value of Forest Research and Education cannot easily be reckoned in rupees, annas and pies, the opinion is often expressed that the scheme of development already sanctioned is far too ambitious, and that the expenditure will not be justified by results. It is often stated that money should not be spent on research and education at the expense of forest works in the provinces, as these last produce more revenue in shorter time. A detailed discussion of the value of Research work, particularly in the Economic Branch, will clearly establish the fact that Research work 'pays'. Up to the present the expenditure on the Forest Research Institute has not exceeded 2½ per cent. of the gross expenditure of the Forest Department, surely a very small percentage. If those officers, who are responsible for the carrying out of Forest works, think this is too large a percentage, they should remember that

expenditure on Forest works is almost entirely a Provincial matter, whereas Research is an Imperial Government concern. It is up to local officers to make out better cases for themselves with their Provincial Governments if they require money urgently for works. It should be remembered that the shortage of officers very often prevents schemes from being worked out carefully in detail before they are put up to Government for sanction, and that the failure of immature schemes results in Government losing confidence in the good judgment of their officers. The present financial stringency should at least have the effect of making us realise that it is better to be content with one or two really productive, and carefully worked out schemes, than to aim at producing revenue in all directions by an indiscriminate expenditure of money. It should help us to realise that it is better to refuse money for schemes unless the whole expenditure necessary for success can be sanctioned. It is no use launching a big felling scheme unless the necessary expert staff and equipment are forthcoming for handling the material after it is felled, and for disposing it of to advantage later on.

EFFECT OF THE PRESENT FINANCIAL STRINGENCY ON THE NEW SITE SCHEME.

As stated above it is expected that the Inchcape Committee will have a 'cut' at the New Site scheme. The Government of India have already largely anticipated events by putting a stop to all fresh constructional work. Only the workshops of the Economic Branch are being built and fitted. But even the fate of the Economic Branch is still in the balance. The uncertainty is causing a great deal of harm, as the specialists who have been engaged on short term contracts are anxious about their futures. Their contracts expire in a few months' time. They feel that they have been able to do very little of the work for which they were engaged. They have not, for instance, been able to train any Forest Officers to take their places, as Government would not allow any appointments to be made. Nor have these experts been able to organise their respective sections and get them into proper running order. The necessity for retrench-

ment has considerably delayed the construction of the buildings of the New Site, and has hampered the work of Plant erection. An instance of this is the action of the Mussoorie Dehra Dun Municipalities who had arranged to supply both electric power and water. The supply of electric power was due in October, so that the Iron Workshop machines could be worked in connection with the erection and fitting of the various plant. The power was supplied only quite recently, with the result that the fitting has had to be done largely by hand, a very tedious business where so much threading and drilling was necessary. With regard to the water-supply, the Municipality recently, quite suddenly, announced that they were unable to put it in at all, owing to the suspension by the local Government, of the necessary grant. This is a very serious matter. The Forest authorities are now faced with the problem of putting in their own water-supply. This was the original intention, but was dropped when it was thought that a combined scheme with the Dehra Dun Municipality would prove better and cheaper. There are now two alternatives. One a temporary scheme for filtering the canal water, which would cost about Rs. 44,000 and would provide water for the boiler and kilns within three or four months of the work being undertaken. This water would be of doubtful value for drinking purposes. The other scheme is of a permanent nature, and is estimated to cost about Rs. 2,10,000. This would furnish water fit for drinking within ten or twelve months. The authorities here are in favour of the latter scheme, and are pressing Government to sanction the necessary expenditure as soon as possible. In the meantime the kilns and the plant dependent on the Boiler cannot begin work, though all the fitting and erection work is expected to be quite complete by April next. Thus there is no hope of the New Site being in working order before the various experts who have been engaged are due to leave India. All are hoping that the Inchcape Committee will make it possible for Government to renew their contracts before it becomes too late.

The need for Commercial Research.—As stated above, the value of Research work cannot be gauged in rupees, annas and pies. It needs to be pointed out, however, that Research performs

a double rôle. More important than its function of producing direct revenue is the part which Research plays in the saving of expenditure. To perform these two functions the work must be properly organised, and should be carried out by well trained and efficient men. In other words, the work should be done by experts, who should be furnished with such equipment and staff as they consider necessary for the carrying out of a full programme of development. A few, somewhat spectacular, instances of the extraordinary results which have recently been achieved at Dehra Dun may be quoted, but these instances do not represent the real value of the bulk of the Research work which is being carried on from day to day. Much of this work must necessarily be concerned with the collection, classification and collation of data. Recently a wood called Sundri (*Heriteria minor*) has been substituted for Hickory in the manufacture of Sucker Rods for the oil wells in Burma. *Terminalia tomentosa* has also been tested, and it is believed will prove a success. The replacement of Hickory by Indian woods will, in this case, lead to a saving of several lakhs of expenditure, as Hickory, an American wood, is becoming scarce and very expensive. Another important discovery which will bring in lakhs of revenue to Government is the discovery, by Dr. Simonsen, the Forest Chemist, of the catalytic action of Pyrogallol in preventing the oxidation of Indian turpentine. As a result of this discovery it will now be possible to advertise Indian Turpentine, Grade I, as equal in quality to the best American. The discovery will cost practically nothing to put into operation, but will make a marked difference to the revenue budgets of the Resin Factories. Another very remarkable discovery by the Forest Chemist is that the drug Santonin can be inexpensively extracted from the plant *Artemisia maritima*, which is a common plant in Kashmir and parts of the Punjab. Mr. Coventry, of the I. F. S., till recently Conservator of Forests in Kashmir, initiated the enquiry which led to the discovery. Santonin used to be obtained chiefly from Russia. Owing to this source of supply having ceased, the drug has become very expensive. it is used chiefly as a vermicide. As the result of the above-mentioned discovery the collection of the plant will be undertaken

on a commercial scale. One collector started collecting just as the last season was closing and, without any proper organisation, succeeded in collecting in a short time sufficient raw material to make enough Santonin to fetch fifteen lakhs of rupees at the present price of Santonin. The price is, of course, bound to come down as the output increases.

These striking instances are given to prove that Research work may be justified simply by one or two lucky discoveries. But the general value of Research Work is worth very much more to the country. The work which is being done, for instance, by the experts of the Economic Branch is certainly worth lakhs of rupees a year. They would be worth considerably more if they had sufficient staff and equipment to enable them to carry out a full programme.

The ultimate goal of this scientific research is to develop the natural resources of the forests and thereby the trade and commerce of the country. India may be rendered more and more independent of outside commodities by intelligent application of the vast esources which at present remain unexploited, but to achieve this nd research should not merely keep pace with industrial and economic developments it should anticipate actual requirements so as to initiate new enterprise. Hitherto forest research has lagged years behind the requirements of the country.

The value of the Economic Branch.—It is, unfortunately, well known that Teak, Sal, Deodar and some well known Australian and American woods are generally preferred, in India, for all constructional purposes. Even for Railway Sleepers hardly any other species are in general use. The Timber Testing Officer at Dehra Dun is now demonstrating to us that there are several cheaper timbers which are stronger, and in some ways better, than those mentioned above. Some of these cheaper timbers even approach mild steel in strength. But because they are a little bit difficult to season, or are subject to white-ant attack when placed in exposed situations, they are hardly ever used. Seasoning and Preservation are generally regarded as expensive luxuries only because hardly anyone in India knows anything at all about them. Now, the Seasoning Specialist at Dehra Dun can, if given

the chance, show how successfully, and comparatively cheaply, the most refractory timbers can be seasoned, either by natural methods, or by means of a Dry-kiln, as circumstances may require. Similarly the Preservation Specialist will, when he materialises, demonstrate how timbers, treated for special purposes, are still cheaper, and, probably, better than some of the naturally immune timbers. (At present the Preservation Section is in charge of the Forest Economist himself.) The work that these officers are doing has hardly yet begun to bear much fruit, owing to their activities having been restricted through the want of staff, equipment and funds. But once these disabilities have been removed, and the general public have been provided with hard facts, which will open their eyes to the value of Indian timbers, there will be a wonderful change in the present state of affairs. Instead of the market being flooded with expensive foreign timbers, the foreign market will be demanding Indian timbers. This state of affairs can only come about as the result of definite Research work along the lines of Timber Testing, Timber Seasoning and Timber Preservation. It may also be anticipated that there will not only be an increase in the export of timber, and a decrease in its import, but also a very material increase in the local consumption of Forest Products generally. Timber is, of course, an ideal material for constructional purposes on account of its light weight, durability, strength, adaptability and low cost. Yet in 1913 the consumption of wood, per head of the population, was only 0·8 c. ft. in India. In America, during the same year, the consumption was as much as 260·0 c. ft. per head. These figures will show how much room there is for the development of the forest resources of a country, the percentage of forest area of which is as great as that of the United States.

An example of the value of a Research Officer's opinion, even before he has had time to do much detailed work may be given. The practice in this country with regard to the seasoning of timber is to "season it in the log." This fact alone probably accounts for a great deal of the prejudice which exists against most timbers except teak. The latter is supposed to be seasoned by means of girdling prior to felling. The real object of the

girdling is to get rid of some of the free water which the tree contains when green, so as to make the timber light enough to float. Most other species will suffer from insect and fungus attack if allowed to remain girdled for any length of time. Consequently these other species do not get such a good chance of drying as does teak, that is to say of drying "in the log." As a general rule logs are sawn up by hand into the particular sizes of scantlings and planks that are required for a particular purpose, and the sawing is usually done 'on the spot'. The sawn timber, therefore, has very little chance of seasoning before it is actually used. Even in the case of large sawmills in India a Seasoning Kiln has not, so far, been considered a necessity. And extremely little trouble is taken to see that the Mill sawn wood is properly air-seasoned before it is sold or used. The protection of the sawn wood from the deteriorating effects of sun, wind and rain is often a matter of chance. In view of the fact that teak is much drier than other species to begin with, and as it possesses a natural oil, which, on exposure to the air, and particularly to heat, forms a waterproof like layer on the surface of the wood, it is able to withstand changes of temperature and humidity better than other woods, even though it is still *quite green.* If Teak had not had these peculiar advantages over other woods it is very likely that the question of seasoning would have been taken up and studied properly long ago. Unfortunately the climates of England, Germany and France, where Forest Officers have received their training, are such that the question of seasoning does not assume much importance. It is in America that the subject has been properly studied, because the climate of that country is much more like that of India, that is one of severe extremes. India is, of course, worse even than America. The American seasoning expert at Dehra Dun thinks that it would not be an over-estimate to say that the practice of "seasoning in the log" loses the Department a large proportion of its revenue from Timber, and he is definitely of the opinion that "no seasoning at all" is better than "seasoning in the log," by which he means that timber should, as a rule, be converted as green as possible, and then seasoned in the converted state. Any Forest Officer with

experience of Timber Depôts knows that a fairly fresh hardwood log, which is worth about Re 1-8-0 a cubic foot soon after felling, may not fetch more than Re. 0-4-0 to Re. 0-8-0 a cubic foot soon after lying two or three years in the jungle and sale Depôt. The exploitation of softwood logs is hardly even attempted in most places. The deterioration is brought about by splitting, cracking, rotting and insect attack. Once seasoned and properly stored, sawnwood (lumber) is subject to very little danger from any of the above causes of deterioration. The sooner it is realised that *timber will not season in the log* the better. A very striking instance of this fact may be quoted as a clear proof of the assertion. Mr. Sweet, the Seasoning Expert at Dehra Dun, was asked the other day to advise Messrs. Bird & Co. at Delhi in connection with the kiln-seasoning of small scantlings of Burma Teak, 30″ × 3″ × 3″ in size, required in the construction of plugs for insertion in the patent Stent Concrete Sleeper. In view of the dry climate of the Punjab it is necessary that these plugs should be dried down to a moisture content of 5 per cent. of the bone dry weight of the wood. If the plugs were inserted in a less dry condition than this they would contract in dry weather and fall out. Now, although these Burma Teak scantlings were received at Delhi in the converted state, they possessed, on an average, a moisture content of not less than 25 per cent. Even after 21 days' drying in the Sturtevant kiln which had been erected by Messrs. Bird & Co., these scantlings were brought down to an average moisture content of 15 per cent. only, instead of the required 5 per cent. It was on account of this difficulty that Mr. Sweet's help was asked. This instance is mentioned merely to illustrate that even small scantlings of so-called seasoned Burma Teak are far from being seasoned. It is only the natural oil in the wood which makes it respond so slowly to changes of humidity and temperature that makes teak behave as if it were seasoned. It may well be imagined what little chance other species have of being "seasoned", if this is the condition of Burma teak. The trouble is that hardly anyone knows anything at all about timber seasoning in India. We still have to learn how to handle our logs and dispose of our timber. We also

have to learn the extent to which different timbers have to be seasoned for different purposes, and for different localities. At present no one cares for such important details in connection with the utilisation of timber in India. In fact hardly any of the people who deal in timber in this country know even how to determine the moisture content of a piece of wood. It is certain that if all the timber sold by the Forest Department were sold with a guarantee that it was seasoned within certain defined limits, the revenue of the department could be greatly increased without any increase in output. If the idea were carried a step further, and measures were introduced with a view to standardising, not only the amount of seasoning, but also the sizes and qualities of timbers offered for sale, all classes of timber users and producers would benefit to an extent at present quite undreamed of. A great deal of work will have to be done first by the Timber Testing Officer, before any proper system of standardising can be introduced. It is estimated that in America a reduction of 20 per cent in standard sizes has been effected as the result of Research Work by the Forest Department. This means a saving of 40,000,000 dollars a year to America, if she acts up to the information available. Anyone requiring further information in connection with the problems connected with the seasoning of Indian Timbers should read the Forest Record by Mr. Sweet on "The Air-Seasoning of Indian Timbers" which has just been issued from the Government Press, Calcutta.

(*To be continued.*)

R. P. DALLEY, I.F.S.

ARTOCARPUS HIRSUTA AS AN UNDERWOOD FOR TEAK.

One of the problems, laid down for solution, in Bourne's Working Plan for the teak plantations in the Nilambur Valley is that of establishing an underwood.

It is clearly indicated that the species chosen should be evergreen, as during the growing season it will be subjected to heavy shade—the density varying with the age of the teak crop under which it is introduced.

Sporadic experiments have been made during the last two or three years with *Hopea parviflora* and *Artocarpus hirsuta*, but owing to the Moplah rebellion, these have failed through insufficient weeding.

With a view to restarting the experiments at the beginning of the next growing season I visited, last September, some plantations of teak at Koni, in Travancore, where Bourdillon, in his "Travancore Timbers" mentions a successful introduction of *Artocarpus hirsuta* as an underwood.

The area in question is probably as good as any in the neighbourhood, and the factors of the locality correspond very closely to those of the best areas at Nilambur. The plantation has an elevation of about 100′ and slopes gently towards a river. The annual rainfall is about 120″, but is, I think, more advantageously distributed than at Nilambur, as the South-West monsoon is generally lighter and the North-East heavier in Travancore than in Malabar.

Three or four attempts to establish *Artocarpus hirsuta* were made between 1892 and 1900 under teak of varying age ; in every case germination took place, but no seedlings survived two hot weathers. "In 1904" (I quote from information supplied by the D. F. O.) "the plantation of 1867 (10 acres) was undersown with *anjilli* seeds (*A. hirsuta*). The ground was cleared of all undergrowth, the seeds were sown broadcast, and *the soil was then hoed up with spade and pick-axe and the seeds covered with earth.*

All the seeds germinated and the plants are thriving well, though they are damaged every year by wild elephants. The trees are now 18 years old and the biggest measure 38″ at breast height. Weedings were done regularly till 1914."

Equal success was obtained by similar methods in 1907. The D. F. O. gave me the girths of 20 trees recently measured in the 1904 and 1907 experimental areas. The average was 27·9″ and 26·0″ respectively. I am not clear, however, on what principle these 20 trees were selected. The ground is seriously overstocked and the actual average tree probably does not exceed 18″ in girth.

I myself selected a number of dominating trees in the 1904 area, if any tree in an underwood can be called dominating, which, in my opinion, were worthy of encouragement at the expense of the neighbouring saplings, and the average of these worked out at 8·2″ diameter—taking two diameters at right angles for each of 15 trees—with a height of 47′.

I selected a typical square chain of ground and counted on it 5 teak standards and 93 *anjilli (A. hirsuta)* saplings, a number which gives some idea of the density of the crop.

Here and there saplings more isolated than their fellows attained a girth of from 36″—44″ and it seems almost certain that normal thinnings in the past—even at a loss, for there is no local market for saplings—would have ensured an exceedingly valuable secondary crop which could be profitably left for 15 – 20 years after the teak is removed, say in fifteen years time, to the benefit of both the state revenues and the soil.

Apart from financial considerations of the future, the teak is definitely freer from epicormic branches than that in the pure plantations of equal age. The difference is certainly small, but the teak was 39 years old when the *anjilli* was introduced and most of the epicormic branches were by then firmly established.

I saw also a plantation of 10 acres where teak and *anjilli* were simultaneously introduced in 1906 at a spacing of 3′ × 3′. Generally the *anjilli* has held its own and is competing on equal terms with the teak, though in small patches here and there only teak is to be found.

This system has obvious advantages, and the Travancore Forest Department do not appear yet to have decided which species they propose to favour.

If, however, a complete underwood could be established in a plantation of teak just before its second or perhaps third thinning, it should grow up fast enough to suppress epicormic branches on the teak, while judicious thinning would prevent any interference with the crowns of the main crop.

I am much indebted to the Conservator of Forests, Travancore, and the District Forest Officer, Koni, for the information and assistance I received and perhaps others with experience of the subject could offer suggestions.

J. M. SWEET, I.F.S.

A SHORT TREATISE ON THE MANAGEMENT OF ELEPHANTS.

BY A. J. W. MILROY, B.A., I.F.S.

Price Rs. 2, obtainable from Officer-in-charge, Secretariat Book Depôt, Shillong, Assam.

We have read with considerable edification this short treatise and can recommend it as a useful handbook that should be given

to every young Forest Officer who is likely to have anything to do with the handling of elephants. The treatise deals with the subjects from the practical side and contains a number of practical hints of value. Especially good is the manner in which Mr. Milroy emphasises, that a study of the natural habits of elephants should form the basis of all arrangements for the attention and care required in their handling. While agreeing, that when properly handled, elephants are not delicate animals, we do not see the necessity for the continual reiteration of this fact, especially in a handbook written ostensibly for young officers. The detailed notes that Mr. Milroy gives are sufficient to prove that an elephant is immediately affected by any unwise handling. An elephant in its natural existence is not a delicate animal, but it must be remembered that elephants are not like most domesticated animals of burden, that have been bred in captivity, and have gradually acquired the habit of life suited to the requirements of their domesticated form of living. Elephants have rarely been more than 1 or 2 generations in captivity. The majority is even born in the wild state, and it naturally follows that great care must be taken in accustoming elephants to conditions and work that are not natural to them. The treatise deals under separate chapters with the following subjects :—

(1) General, *i.e.*, Identification, types and good and bad points; points to be noted when purchasing new animals.

(2) General management and feeding. This is very well dealt with.

(3) Working.—This portion suffers from a general point of view, in having no reference to the dragging of timber, which in Burma, at any rate, is of primary importance, but it is obvious that Mr. Milroy has had little experience of this branch of work, as elephants are not used for dragging to any great extent in Assam.

(4) Gear and loads.—This again makes no reference to dragging gear.

(5) Ailments and diseases, with the more simple remedies and treatment.

The treatise concludes with a useful glossary of terms, and a number of photographs illustrating the different types of elephants and gear. The photos of elephants have not been treated very well in reproduction and do not give a very good idea of the types they are supposed to illustrate.

The treatise is, of course, written by an Assam Forest Officer mainly for the benefit of officers employed in Assam and similar localities, such as Bengal. Naturally, therefore, it deals at some length, with the artificial life of an elephant at *pilkhanas* (elephant-lines) and with handfeeding; but the author quite rightly emphasises the advantages to be gained, where natural fodder is plentiful, of allowing the elephant to find its own food, while preventing it from straying by hobbling its forelegs. In Burma, with its wider forests, and greater abundance of natural fodder, a good many of the directions with regard to feeding and to permanent *pilkhanas* are unnecessary.

We have sent this book to one of our elephant experts, who has kindly supplied the following notes:—

"The author has no objection to mahouts riding at ease on the top of the baggage and occasionally poking the elephant's head with a stick. A much better pace, and better control is obtained, by the mahout's riding on the animal's neck, and occasionally tickling its ears with his toes. Rope stirrups may be used with advantage both to prevent tiredness in the mahout's legs and to keep his feet well forward against the elephant's ears.

"No mention is made of the advisability of personally seeing the girths are pulled tight before a loaded elephant leaves camp, nor of the mahout's massaging the elephant's back after unloading, two practices which go far to prevent girth-galls and sore-backs.

"That paddy fed to elephants should be well boiled before mixing with salt, is not mentioned. Unless this is done,

much paddy will pass through the system undigested, and colic and indigestion may result.

"Another point which might have been mentioned, is the advisability of every officer travelling with elephants, taking, as a regular part of his kit, such simple medicines as iodine, zinc ointment and dusting powder, and on a long tour, purgatives and some iron tonic, powders or balls. Solutions of salts giving off free chlorine, which are found very effective in cleaning up suppurating wounds, afford a non-bulky and useful adjunct to the medicine chest, and might well be included."

Without detracting in any way from the general usefulness of the book, it must be admitted, that the work lacks arrangement, and gives the impression ot consisting of a number of loose notes strung together without very much continuity. Above all, it has suffered exceedingly in the hands of the printer. It is comforting to find that, even the much maligned Burma Government Press can, as a general rule, turn out a better article than this sample of the work of the Assam Government Press, Shillong.

H. R. B.

AFFORESTATION IN KOREA.

By Professor Percy M. Roxby.

While passing through Korea last year *en route* to China I was able to collect some interesting information about the wonderful afforestation scheme which the Japanese authorities are carrying out in that beautiful but long-neglected country. It is probably the most systematic and ambitious effort at afforestation on a national scale which has so far been attempted, and is not without its lessons for this country. A singularly favourable opportunity for State enterprise was presented by the fact that the Japanese Government, succeeding to the Crown Lands of the Korean Royal House on the annexation of the country in 1910, came into possession of about seven-eighths of the total area of "Hills and Mountains" (14,000,000 out of an estimated total of 16,000,000 *cho**), which constitute the greater part of the land-surface of Korea. This opportunity was eagerly seized by the new Administration, bent on the rapid economic development of the country, since afforestation was held to be an essential preliminary to both agricultural and industrial progress. Originally the granitic highlands of Korea were fairly densely wooded, but over the greater part of the country the natural forests have been almost totally destroyed, with results disastrous to both agriculture and pasturage. The only large area of primitive forest remaining is in the north-east, a portion of

* A *cho* is equal to 2 45 acres approximately.

the rich belt of mixed woodlands which occupies the basin of the Upper Yalu, and stretches northwards towards the Amur. On the Manchurian side of the border much reckless destruction of this important forest is taking place, but its exploitation on the Korean side is being carefully regulated. The Government have maintained a large lumber station (at Shingishū) which controls the use of the forest. The working principle at the present time is to cut down 1/120th of the forest each year and to replant to the same extent.

Meanwhile, the re-afforestation of the denuded highlands of central and southern Korea has begun in real earnest, and I was much impressed by the great progress which has been made since 1913 when I first travelled through the peninsula. About 2,50,000 *cho* have already been planted, one-half directly by Government, and the other by private individuals to whom the land is rented, on the express understanding, that planting shall be the first consideration. At the end of ten years that land will pass to the individuals concerned, provided that the Administration is satisfied with its forestal use in their hands. At present about 150,000,000 seedlings per year are being planted, at the rate of about 3,000 to 5,000 per *cho*.

On the hills the trees planted are mainly Korean pines of the two and five-leaved varieties. They come to maturity in about forty years, and are from 50 to 60 feet in height. The chief difficulty is to prevent depredations by the peasantry for purposes of fuel, and so, to prevent destruction of the hill forests, acacias, Lombardy poplars, and other quick growing trees are now being extensively planted on waste places in the lowlands and valleys for local use. According to the officials concerned with the scheme it is the intention of the Government to retain as State forest about six million *cho* of the large area at present under their administration, and to allow the other eight millions to pass into private hands on the conditions specified above.

The results anticipated by the Japanese forestry experts from this scheme, apart from the supply of timber essential to the development of many Korean industries, are as follows :—

(1) Modifications of climate : (*a*) value of trees as wind-screens ; (*b*) tendency to increase equability of

temperature; (*c*) probably a slightly increased rainfall, since the bare granite rocks when heated tend to check condensation.

(2) The prevention or at least reduction of both floods and droughts by checking the rapid run off of water from the hills. This of itself will be an immense gain to agriculture, but in addition it should be noticed that

(3) Afforestation is considered a necessary preliminary to the extensive irrigation schemes by which it is hoped to increase the agricultural area of the country. These depend upon the construction of irrigation reservoirs, which at present it is almost useless to make owing to their being quickly silted up by the torrential run of water.

(4) The development of cattle and sheep pasture.

(5) The preservation and improvement of the valued supply of fish in the rivers and estuaries, through the more even flow of water.

(6) It is also interesting to notice that the Japanese attach importance to the improvement of health through pine forests, both by their effect on the purification of the air, and by the enhanced beauty which they give to the landscape.

The cost to the Government of this big scheme, including the upkeep of the lumber station in the north, is estimated at about yen 3,500,000 per year.

To encourage popular interest in afforestation, Arbor Day (significantly fixed on 3rd April, the conventional anniversary of the death of the famous Jimmu Tenno, the first Emperor of Japan) has been made a national institution.

The afforestation of Korea has, of course, a high significance for China, which is faced with the same problems due to the destruction of her forests, but on a far more gigantic scale.—[*The Scottish Geographical Magazine, Vol. XXXIX, No.* 1.]

RECORD OF WAR SERVICES.

Alington, G. H.

Burma.—I. A. R. O., June 1915. Attached 2/9th Gurkhas, Mesopotamia. Killed in action, 24th February 1917.

Bailey, W. A.

United Provinces.—Attached 1/7th Gurkha Rifles, October 1916. Seistan Field Force, July—October 1917. Depôt Adjutant, November 1917. Recalled, January 1919.

Barrington, A. H. M.

Burma.—I. A. R. O., July 1918. Attached 2/70th Burma Rifles. Recalled, February 1919.

Beeson, C. F. C.

Research Institute (Punjab).—Captain, attached R. A. M. C. Specialist appointment. Mesopotamia, May 1916—July 1917.

Bourke, D. R. S.

Bombay.—July 1916, 3rd Sappers and Miners, Mesopotamia. September 1916, 48th Pioneers, Mesopotamia. November 1917, Department of Local Resources, M. E. F. December 1918 to September 1919, Officer in charge of Forest Survey, Mesopotamia, Captain.

Brcoks, J. B.

Bombay.—I. A. R. O., 1/6th Gurkha Rifles. Attached 2/2nd Gurkha Rifles, Tonk, N.-W. F., Captain and Company Commander. Recalled, November 1918.

Carroll, E. W.

Burma.—I. A. R. O., July 1918. 2nd Sappers and Miners. Recalled, February 1919.

Collings, F. W.

Burma.—May 1918, Staff Duties. I. A. R. O., East Persian Field Force.

Cooper, H. L.

Assam.—I. A. R. O., 1918. Attached 2/11th Gurkhas. Released 1919.

Corbould, P. S.

Central Provinces.—Previous War Service, South Africa, 1900. I. A. R. O., September 1910. Mobilised with 4th Royal Berks in England, August 1914. Station Staff Officer, Deolali, December 1915. Cantonment Magistrate, Deolali, February 1916. Kirkee and Poona, August 1916. Captain. Recalled, April 1919.

Courthope, E. A.

United Provinces.—I. A. R. O., attached 1/39th Garhwal Rifles, April 1915. France, August 1915. Attached as Director of Works, October 1915 to April 1916. Attached to 12th (P. of W.) West Yorks Regiment, April 1916. Wounded, July 1916. Attached 1/39th Garhwal Rifles in India, July 1917. October 1918, France, Field Major to Chief Engineer, L. of C. Demobilised, January 1920.

Cowan, J. M.

Bengal.—R. F. A., Ammunition column, Palestine.

Cox, C. E. C.

Central Provinces.—I. A. R. O., attached 12th Cavalry, Mesopotamia, November 1915; Nazarieh and Butaniyeh, 1916. Compelled to relinquish commission as a result of serious illness contracted on service.

Dalley, R. P.

Bombay.—I. A. R. O., attached 35th Scinde Horse. Captain and Squadron Commander, July 1916 to September 1917. Embarkation Staff at Bombay till February 1918. Signal Service Depôt, Poona. Commanded 10th Cavalry Brigade Signal Troops at Peshawar, July 1918. Recalled, November 1918.

David, A. N.

Assam.—R. A. F. Salonika. (Details not known.)

Davis, A. P.

Burma.—I. A. R. O., attached S. and T. Corps. Attached 2/70th Burma Rifles, May 1918.

Dickson, A. F.

Burma.—I. A. R. O. June 1915. Killed in action in Mesopotamia, July 1918.

Donald, J.

Central Provinces.—I. A. R. O., June 1915. Attached 2nd Sappers and Miners, Quetta. Died of heart failure.

Eden, A. E.

Burma.—I. A. R. O., August 1918. Attached 2/70th Burma Rifles.

Ellis, E. V.

Burma.—Howe Bn., R. N. V. R., December 1914, Gallipoli, France. Awarded Military Cross. Died of wounds in France, February 1917.

George, A. L.

Burma.—(P.F.S.)—July 1916—October 1917. Vol. M. G. Battery.

George, H. S.

Central Provinces.—I. A. R. O., attached 1st K.G.O. Sappers and Miners, Mesopotamia, March 1918. Special Service Officer with Sirmur Sappers. Recalled, March 1919.

Golding, G. H. A.

Burma.—I. A. R. O., February 1916. Attached 1/91st Punjabis, Mesopotamia, Palestine. Mentioned in General Allenby's despatches. Wounded.

Greswell, E. A.

Punjab.—I. A. R. O., attached 32nd Sikh Pioneers, December 1916. Appointed Deputy Controller, Timber Supplies, Punjab, Indian Munitions Board, March 1917. Captain.

Gwyer, C.

Burma.—Joined Army when on long leave. Resigned, September 1915 Later killed in action in France.

Harlow, C. M.

Central Provinces.—I.A.R.O., April 1917. Attached 1/32nd Sikh Pioneers, Mesopotamia. Captain and Adjutant. Recalled, March 1919.

Hargreaves, C. K.

Burma—I. A. R. O., August 1918. Attached Burma Rifles. Recalled, February 1919.

Hartnoll, E. S.

Burma.—I. A. R. O., October 1917. Attached 1/70th Burma Rifles, Palestine.

Hay, E. F. A.

Burma.—King Edwards Horse.—I. A. R. O., October 1917. 3/153rd Rifles, 1/70th Burma Rifles, Egypt.

Herbert, V. A.

United Provinces.—May 1915. Attached 14th Lancers, Mohmand Expedition, November 1915. Base Commandant's Staff, Marseilles, May 1916. Attached 29th Lancers, France, March 1918. Palestine, till May 1919. Adjutant of Regiment, January 1917 to May 1919. Awarded Military Cross.

Hewett, D. P.

Burma.—I. A. R. O., November 1917. 22nd Cavalry F. F. 3/70th Burma Rifles. Recalled, February 1919.

Hopwood, J. C.

Burma.—On leave. War Work in London.

Hopwood, S. F.

Burma.—Joined R. F. A., January 1916, when on leave. Wounded in France, September 1918. Awarded Military Cross.

Inder, R. W.

Bombay.—I. A. R. O., August 1916. Assistant Recruiting Officer, Berar and Khandesh, later transferred to Gujrat and Kathiawar. Recalled, April 1918. Captain.

Jeffery, G. R.

Burma.—Joined 20th Hussars when on leave. Killed in action in France, 14th February 1916.

Jenkin, R. T.

Central Provinces.—S. and T. Corps, April 1915. Assistant Postal Censor, attached 105th Mahratta Light Infantry, September 1915. S. and T. Corps January 1916. Afghanistan. Captain.

Jerram, M. R. K.

Punjab.—I. A. R. O., attached 2/2nd K. E. O. Gurkhas, 1915. Aden, France and Egypt, 1915. 1/2nd K. E. O. Gurkhas, Mesopotamia, 1916—1918. Attached 2/11th Gurkhas in India, 1918—1919. Severely wounded in Mesopotamia, 1917. Captain. Twice mentioned in despatches. Awarded Military Cross.

Jollye, H. C. B.

Central Provinces.—I. A. R. O., attached 31st D. C. O. Lancers, Kohat and Bannu, September 1916. Assistant Recruiting Officer, November 1917. Assistant Controller, Timber Supplies, Munitions Board, November 1918—March 1919. Invalided from Waziristan Field Force, August 1917. Captain.

Lawrence, A.

Burma.—May—August 1918. Staff Training.

Lyall, J. H.

United Provinces.—1/123rd Outram's Rifles, November 1916. Mesopotamia, March 1917. Attached 1/26th Punjabis. Baghdad, April 1917. Palestine July 1918. Attached 1/152nd Punjabis. Released, 16th April 1919. Captain.

Mackarness, C. G.

Assam.—I. A. R. O., November 1915. Attached 25th Punjabis. Assistant Recruiting Officer, April 1916. Attached 52nd Sikhs, April 1918. Palestine, Special Service Officer with Alwar Imperial Service Infantry (A/Capt.) to January 1919.

Mason, L.

Central Provinces.—R. F. A., October 1914. France, January 1915 to February 1919. A.-D.-C. to

G. O. C., R. A., 4th Division. Staff Captain, R. A., 4th Division. Staff Officer, R. A., 3rd Army. Acting Major, February 1918. Twice mentioned in despatches. Awarded Military Cross, O.B.E., Croix de Guerre Belge.

McDonald, D. C.

Central Provinces (P. F. S.)—I. A. R. O., attached 104th Wellesley's Rifles. Regimental Recruiting Officer, 1918.

Milne, W. C.

Bombay.—121st Pioneers, July 1916. Mesopotamia, March 1917. Died of enteric fever in Baghdad, 29th October 1917.

Milner, C. E.

Burma.—I. A. R. O., May 1915, 38th Central Indian Horse. France. Wounded at Cambrai, January 1918 to January 1919. Timber Supply Department, Board of Trade, to superintend felling and extraction of ash for æroplanes.

Milroy, A. J. W.

Assam.—I. A. R. O., January 1918. Attached 3/9th Gurkhas. Released, April 1919.

Milward, R. C.

United Provinces.—Attached 102nd and 101st Grenadiers and deputed to Kapurthala and Gwalior Imperial Service Troops. British East Africa, August 1915—May 1916.

Nicholson, A. R.

Bengal.—Mesopotamia. Twice severely wounded.

Nicholson, J. W.

Bihar and Orissa—I. A. R. O., August 1916. Attached 12th Cavalry, Mesopotamia, June 1917—March 1919.

Ogilvie, G. H.

Burma.—Censor at Rangoon. I. A. R. O., December 1914. 2/10th Gurkha Rifles. 2/3rd Gurkha Rifles. Dardanelles, Mesopotamia, Palestine. Wounded,

September 1918. Captain. Awarded Military Cross. Mentioned in despatches.

Owden, J. S.

Assam.—I. A. R. O., November 1915. Attached 4th Cavalry, Mesopotamia, April 1916. January 1917 joined R. F. C., November 1917, Aden with 1/14th Squadron. Wounded, January 1918. Recalled in 1919. Mentioned in despatches.

Parker, R. N.

Punjab.—I. A. R. O., October 1917. Assistant Controller of contracts in charge firewood supplies at A. H.-Q. (Temporary Major), December 1917. Recalled, March 1919.

Patterson, C. B.

United Provinces.—June 1915, attached 1/1st Gurkha Rifles. Attached 39th Garhwal Rifles, Mesopotamia. Attached 1/1st Gurkha Rifles. Killed in action, January 1917.

Powell, W. S.

Burma.—I. A. R. O., December 1917. 6th K. E. O. Cavalry, December 1917. Recalled, February 1919.

Rodger, A.

Burma.—Timber Supply (Munitions), 1917—1919.

Rowbotham, C. J.

Assam.—I. A. R. O., August 1916. Attached 1/123rd Outram's Rifles, November 1916. Mesopotamia, April 1917. Attached 93rd Burma Infantry, Palestine, May 1918. Suez, April 1919. Invalided to England, July 1919. Recalled, May 1920.

Scott, C. W.

Burma.—R. N. A. S., 243rd Squadron, R. A. F. European waters. Mentioned in Naval despatches, 1917. Mentioned in R. A. F. despatches, 1918. D. F. C., January 1919. Major.

Shebbeare, E. O.

Bengal.—I. A. R. O., June 1918. A. P. M., Calcutta, Recalled, August 1918.

Shepherd, W. S.

Burma.—I. A. R. O., June 1915. 10th Lancers, 9th Hodson's Horse, France. Wounded in Palestine, September 1918.

Shirley, G. S.

Burma.—I. A. R. O., August 1918, Burma Rifles. Recalled, February 1919.

Simeon, G. N.

Assam.—I. A. R. O., October 1915, attached 2/1st K. G. O., Gurkha Rifles. January 1917, attached 3/3rd Q. A. O. Gurkhas, Egypt, June 1917—December 1918. Attached E. E. F. Imperial School of Instruction. Recalled, March 1919.

Simmons, C. E.

Assam.—I. A. R. O., attached Supply and Transport Corps, November 1915. Mesopotamia, July 1916. Palestine, June 1918. Adjutant, 3rd Divisional Train. Mentioned in despatches. Mesopotamia, 1917. Recalled, June 1920.

Sitzler, E. A.

Burma.—I. A. R. O., July 1915, 1/9th Gurkhas, 79th Carnatic Infantry, 156th Infantry, Mesopotamia.

Smith, H. C.

Burma.—I. A. R. O., November 1917, 1/70th Burma Rifles, Egypt. Recalled, March 1919.

Sothers, D. B.

Bombay.—I. A. R. O., April 1915, attached 2nd Somerset Light Infantry, Quetta. 114th Mahrattas, July 1915. On service Mohmand Expedition, September and October 1915, and Mesopotamia, May 1916 to December 1918.

Teague, L. E. S.

Bengal.—I. A. R. O., Gurkhas, Palestine.

Thomas, A. R.

Assam.—I. A. R. O., attached S. and T. Corps, July 1916, Mesopotamia. Invalided to India, December 1917.

Trotter, H.

Burma.—I. A. R. O., November 1914, attached 1/2nd Gurkhas, Mesopotamia. Captain. Wounded, February 1917. Military Cross.

Tyndale-Biscoe, H. L.

Burma.—R. N. A. S. and R. A. F., Eastern Mediterranean. Captain.

Walden, G. P.

Burma (P. F. S.).—102nd K. E. O. Grenadier Rifles 107th Pioneers, Mesopotamia, N.-W. Frontier. Recalled, March 1919.

Walker, H. C.

Burma.—May 1918, Staff Training. Recalled, October 1918.

Walsh, A. J.

Burma (P. F. S.).—December 1917, Military Police.

Wright, F. A.

Burma (P. F. S.).—September 1916, 85th Burma Rifles. Recalled, February 1919.

Young, J. V.

Burma.—May 1918, Staff Training. Recalled, August 1918.

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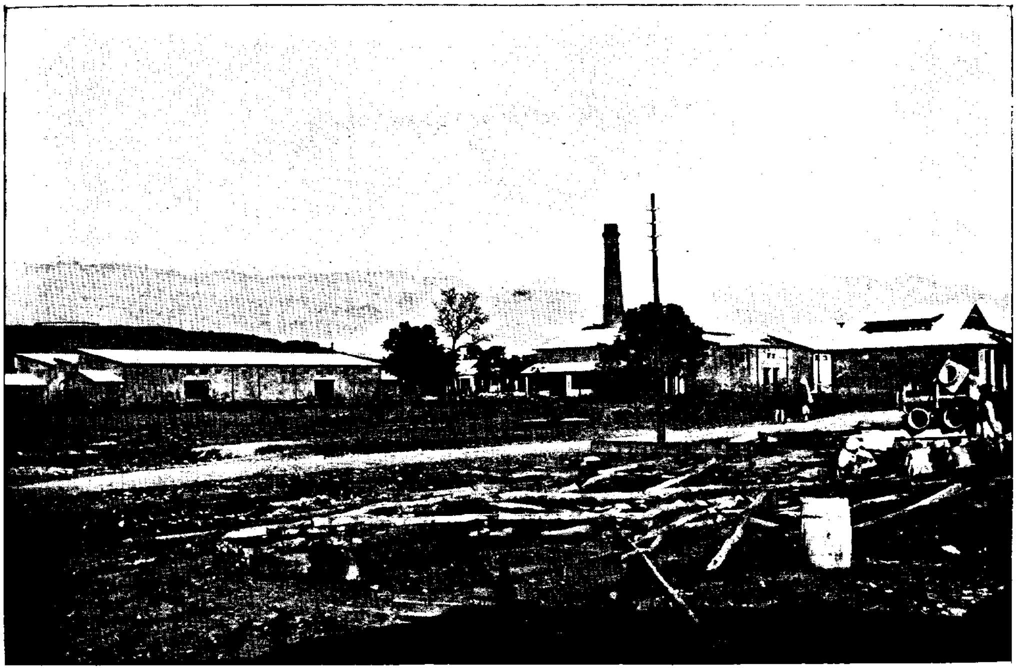
A VISIT TO THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

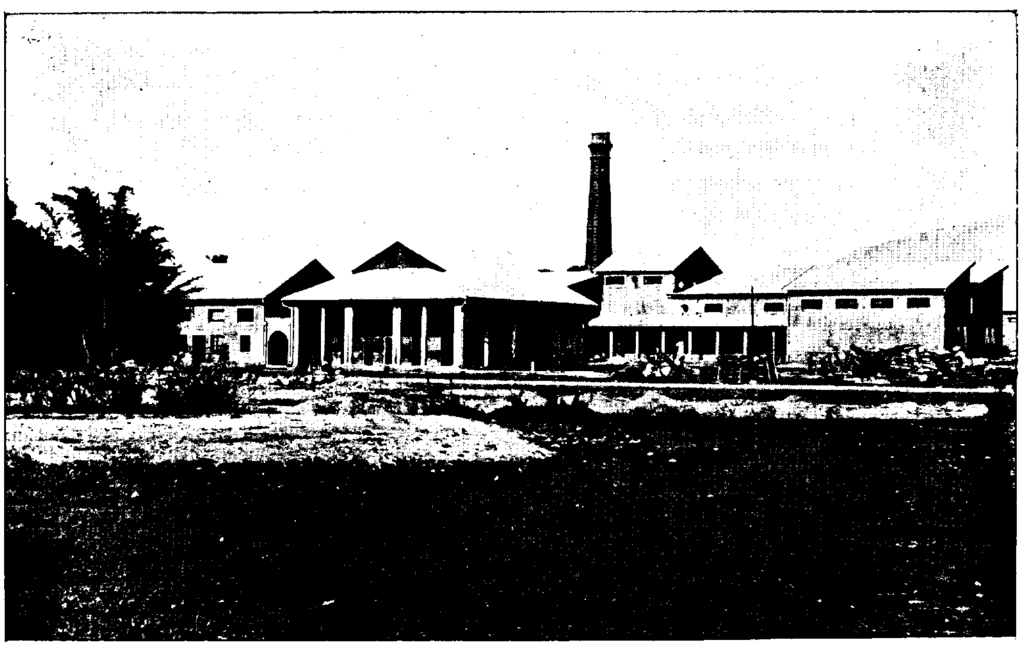
PART II.

The Example of America.—The remarks made above with regard to the possible achievements of Forest Research Work in India are not merely optimistic conjectures. In the United States (which is the most advanced country of any in the matter of Forest Utilisation) the value of Forest Research has been proved over and over again, although the Central Research Institute at Madison, known as The Forest Products Laboratory, has only been in existence since 1910. An instance has already been quoted of how investigation on the mechanical properties of American woods has given knowledge permitting a 20 per cent. increase in allowable working stresses in structural timbers, which means a possible saving of forty million dollars each year. Proper nailing



Godowns | Wood Preservation Plant and Boiler House | Sturtevant Seasoning Kilns

View of part of the Economic Branch, New Forest Research Institute, looking N.E.



Photos. by R. P. Dalley, I.F.S.

Seasoning Laboratory | Tiemann Seasoning Kilns | Pulp and Paper Mill

Another view of the above looking N.W.

and improved box design developed by the Laboratory and adopted by the trade is estimated to save about a million dollars a year in claims for loss and damage to commodities during transit. The adoption of improved methods of turpentining developed by the Forest Service has resulted in increased yields and decreased injury to timber with net savings aggregating 4,000,000 dollars per year. In short, it was estimated that in 1920 the annual *saving* to American industries *directly* attributable to the work of the Laboratory was approximately 30 million dollars. Were full use made of the results of the Laboratory's investigations there was possibility of a very much larger saving. For instance, only 10 per cent. of the possible 40,000,000 dollars referred to above was included in the calculation of actual savings. Again, it was estimated that the *preventable* losses in commercial operations, due to improper air-drying and poor kiln-drying, aggregated annually over one billion dollars at the price of lumber in 1920. These losses are constantly growing less through the widening sphere of Laboratory influence. The following statement, quoted from a recent number of '*The Timberman*', shows another aspect of the value of Research :—' The annual consumption of timber in the U.S.A., exclusive of fuel wood, is over 50,000,000,000 board feet (almost five times the yearly growth), and approximately one-half of it is destroyed by decay. If all timber used in the U.S.A. adapted to treatment (preservative) were treated, it would decrease the drain on the forests by over 10,000,000,000 board feet per year, and still maintain existing conditions of supply and demand. No mention has been made of the extremely valuable war work which was carried out by the Laboratory.

The war brought out with startling clearness the vast importance of wood and other forest products in warfare. The demand for wood for barracks, railways, bridges, telephone and telegraph lines, docks, ships, boxes and crates, furniture and fuel far exceeded the normal peace-time demands. Wood was also required for multitudinous special war uses such as the building of aeroplanes, trucks, artillery and wagon wheels, gunstocks, handles for tools, mortar boxes, posts for entanglements and in the building of trenches. Wood pulp was not only used to a far greater extent in the making of paper, but assumed vast import-

ance in the manufacture of explosives, as a substitute for cotton dressings and in the making of textiles and clothing. The distillation product of wood play an important part in wartime. Methyl alcohol is used in the making of medicines and disinfectants, and in the manufacture of dyes and other products. Acetic acid, turpentine and resin are also greatly in demand. In connection with all these needs the Laboratory at Madison played an extremely important part. Many new investigations and urgent researches had to be carried out. The Army and Navy authorities were soon convinced of the practicability of kiln-drying material green from the saw to a condition equal to or better than air-dried stock, which very soon became exhausted. In connection with aircraft woods specially valuable work was done both in the matter of seasoning, testing and designing as well as in the discovery of suitable substitute woods. Closely associated with this work was the development of water-resistant glues. Countless other problems were solved by the Laboratory staff; for instance, in the preparation of a specification which allowed the use of many different kinds of wood in the manufacture of boxes; in getting over many technical difficulties connected with the building of wooden ships; in recommending the use of zinc chloride for the preservation of sleepers in certain dry localities when there was a shortage of creosote; in finding suitable absorbent charcoal for use in gas-masks; in finding ways and means for producing suitable cellulose from wood for the manufacture of high explosives; by making over 18,000 microscopic identifications of wood and charcoal; and by examining wood, especially wood used in aircraft, for decay. A great deal of instructional work was carried out. Courses were arranged for the training of aeroplane and box inspectors. One of these men designed a new type of cartridge case box which save the Ordnance Department 50,000 dollars on the first contract, besides saving 100,000 dollars worth of cargo space. Numerous kiln operators were also trained.

From the above it will be clear that a real estimate of the value of the work done by the Laboratory since the date of its inception, 1910, cannot be made. But the operating cost of the Laboratory for the first ten years of its existence amounted only

to something under two million dollars, of which the War Period (April 6th, 1917 to November 11th, 1918) accounted for a fairly large portion. Thus if the average annual cost be put down at 200,000 dollars some idea of the direct as well as indirect gain resulting from Forest Research in America can be obtained.

The people of the U.S.A. place the very greatest stress on the importance of Forest Research, and so does the Dominion of Canada. Australia and South Africa are following suit. Though the Forest Products Laboratory at Madison is the Central Research Institute of the Forest Department in America it deals only with subjects which, at Dehra Dun, are regarded as belonging only to the Economic Branch. On Armistice Day the personnel of the Laboratory numbered 458. The summary shown below of the organisation of the controlling staff of the Laboratory will serve to give an idea of its activities. Given the same opportunities there is no reason why Dehra Dun should not develop in the same way. Compared to Madison, the New Site Scheme is merely a short step in the right direction. It possesses, however, one distinct advantage, in that all the branches of Research are concentrated in one place. In America the other branches of Research (Botanical, Silvicultural, Chemical and Entomological are carried out at the various Forestry Schools scattered all over the country.

Organisation of the Forest Products Laboratory at Madison, U.S.A.—The work of the Laboratory is divided into two main Divisions. Each Division has several Branches, Sections and Sub-Sections. The chief controlling officers, and the activities controlled by them, are given below. In addition to these officers at the Central Institute, there are field officers scattered all over the country, who co-operate with the officers at the Laboratory. The Forest Service is under the Department of Agriculture. The head of the Service is known as the Chief Forester. An Assistant Forester is placed in charge of the Branch of Research. The Laboratory is controlled by a Director, and an Assistant Director. The two Divisions of Laboratory Work are (1)

Finance, Service and Extension, and (2) Technical Industrial Research Problems. These are sub-divided as follows :—

1. *Finance Service and Extension.*

Branch.	Section.	Activities.
1 Accounts ...	...	Appointments, Time-keeping, Cost Accounting, Auditing, Disbursement.
2 Publication of Results.	...	Review, Edit, Publication, Distribution.
3. Laboratory Operation.	Computing ...	Calculations, Compilation, Summaries.
	Engineering ...	Drafting, Wood Shop, Sawmill and Yard, Machine Shop and Electrical Shop.
	Photography ...	Report Illustrations, Motion Pictures, Photographic representation of Laboratory data.
	Personnel ...	Employment, Assignment Control, Personal Welfare, Charts, Graphs and Visible Index.
	Quarters ...	Maintenance, Janitor and Watchman Service, Messenger Service, Truck Service, Property Accountability.
	Records ...	Files, Library, Mail Control, Stenography.
	Supplies ...	Procurement, Store-rooms, Warehouse, Shipping.
4. Co-ordination ...	Project Control ...	Status and Progress of Investigative Work.

2. *Technical Industrial Research Problems.*

Branch.	Section.	Activities.
1. Pathology ..	Co-op. B. P. I. (Bureau of Plant Industry).	Methods to prevent Mould and Stain, Storage conditions of Forest Products, Resistance of Wood to decay and Wood-decaying fungi, Building Rots and their prevention, Toxicity of Preservatives.
2. Derived Products	Wood Distillation	Efficiency in Production and Utilisation of Products of Wood-distillation and Extraction.
	Wood Preservatives.	Chemical composition and physical characteristics of Wood Preservatives.
	Ethyl Alcohol ...	Ethyl Alcohol from Sawdust and Waste Sulphite Liquor, Study of the uses of Hydrolysed Sawdust.
	Cellulose Chemistry.	Chemical composition of Wood, Essential Oils, Gums and Balsams.

2. *Technical Industrial Research Problems*—(continued).

Branch.	Section.	Activities.
3. Pulp and Paper	Soda and Sulphate Processes.	Study of the manufacture of Pulp and Paper, Extension of the use of Wood Pulp.
	Sulphite Process...	Manufacture of Pulp and Paper by the Sulphite Process, Utilisation of Waste Bark for Tanning purposes, Suitability of Wood Pulp for the manufacture of Nitrocellulose.
	Chemistry of Pulp	Chemical properties of Commercial and Experimental Pulps obtained by various processes, including bleached Pulps.
4. Preservation ...	Moisture Proofing and Humidity Control.	Development of Moisture Resistant Coatings, Design of Apparatus for Humidity Control in Wood-working dactories
	Wood Preservation	Protection of Wooden Structures from decay, Durability of Treated and Untreated Wood, Protection of Piling from Marine Borers, Efficiency of various Wood Preservatives, Methods of treating Commercial Woods.
	Gluing Problems	Glue Strength and Durability Tests, Plywood manufacturing problems, Problems in gluing laminated Products
	Water Resistant Glues.	Development and Improvement of Water Resistant Glues, Study of Commercial Glues.
5. Timber Mechanics.	Comparison of Species.	Strength of small clear specimens. Influence of defects on strength and limitations of use
	Effect of Treatment on Strength.	Effect of Kiln drying on the strength of Woods, Effects of Steaming and Boiling Bending Stock, Effect of Preservative Treatment on Strength of Wood.
	Manufactured Articles.	Strength and Design of Manufactured Articles, Limitations and Possibilities of Splices and Laminations, Manufactured Articles using small sizes and low grades.
	Plywood ...	Standard Plywood Tests, Plywood Joints and Fastenings, Strength and Design of Plywood forms.
	Structural Timber Grading Rules.	Strength and Use of Structural Timbers, Efficiency of Various Joints and Fastenings.

2. *Technical Industrial Research Problems*—(concluded).

Branch.	Section.	Activities.
	Aircraft Study ...	Factors influencing stresses, strength designs and specifications of fabricated products with special reference to Airplane parts.
	Containers ..	Study of containers and Methods of Packing, Strapping of Wooden Boxes, Instruction of Industrial Representatives.
6. Industrial Investigation.	Specifications and Grades.	Standardisation of Sizes, Grades and Specifications for Lumber, Cross ties (Sleepers), Dimension Stock and other Wooden Products. Adaptation of Species to correct use.
	Industrial Utilisation of Wood.	Studies of Manufacture of Forest Products, Studies of Wood Using Industries. Economic Utilisation of Low Grade and Waste, Statistical and Industrial Study of Wood Uses.
	Dimension Stock Study.	Studies of present and most efficient methods of manufacturing and utilising lumber and small dimension stock.
	Spark Arrester Study.	Study of Spark Arresters and conditions relating to their use.
7. Fundamental Laws of drying Wood.	...	Behaviour of Wood in regard to shrinkage and swelling with moisture changes.
8. Timber Physics	Wood Technology	Determination and Description of Species, Instruction of Industrial Representatives, Relation of Structure to Properties.
	Kiln Drying ...	Study of Commercial Processes and Problems of Kiln-drying. Research in Kiln-drying and Air seasoning various Species. Physical properties affecting the Seasoning of Wood.

India contrasted with the United States.—The above description of the organisation of America's Research Institute shows what an excellent example India has before her if she chooses to develop the Economic Branch of her Research Institute along commercial lines. There is no question about it that, *unless Forest Research is developed as fast as it can possibly be developed*, very little industrial and commercial progress can be made in those industries, and works of improvement and extension which are dependent in

some way on the products of our Forests. By contrast the proposed organisation at Dehra Dun pales into insignificance when compared with that of America. And when it is remembered that India possesses more than ten times the number of commercial timbers that America does, and that the forests of America are mostly privately exploited (to the extent of 97 per cent.), the contrast is even more striking. In India the onus of development and extraction rests almost entirely upon the Forest Department. In America the Forest Department is concerned far more with conservation than exploitation. The need for conservation is very acute for the annual 'cut' is estimated to be quite five times the annual 'yield.' The activities of the Central Research Laboratory are largely concerned with the finding of uses for the less well-known species, and with enquiries into the best methods of prolonging the normal lives of various timbers by means of Seasoning and Preservation. In India a great deal of additional work has to be undertaken by the Forest Department in connection with Logging Schemes, Improved Methods of Transport, and with the Conversion, Storage and Disposal of Timber and other Forest Products. Yet, in spite of the fact that the Forest Department in India has so much more actual commercial work to do than the Forest Department in America, the contact which exists between the Research Institute at Dehra Dun and the commercial world is nothing compared to the ties which exist between commercial life in America and the Laboratory at Madison. In India even the Forest Department knows very little of what is happening at Dehra Dun; the want of co-ordination between Research Officers at Dehra Dun and Forest Officers in the Provinces is most marked. Even in the Provinces we find Circles and Divisions working quite independently of each other. The appointment of Chief Conservators, and of Special Officers to control and co-ordinate work in connection with Silviculture, Working Plans, Utilisation and Research is helping to put matters on a better footing in some Provinces.

The Forest Department must lead the way.—The question naturally arises: 'How best can the Forest Resources of the

country be developed?' The answer is, in one respect, obvious: 'The Forest Department must rise to the occasion and seize the glorious opportunity which it undoubtedly has of capturing completely the Indian Timber Market, and of obtaining a sound and ever-increasing foothold in foreign markets for Indian Forest Products.' The importance of Regeneration, Silviculture and Protection is probably fully realised by every Forest Officer. The importance of the commercial side of the duties of the Department is realised only in a very vague sort of way. The Finance Department are still more hazy in this connection. The public probably realise better the extent to which the Forest Department is lacking in business ability, but they cannot have the slightest idea how matters can be improved. The Forest Department must work out its own salvation, not merely by finding the solution to the problem, but by getting both Government and the public to see and grasp the solution. The Forest Department must lead the way and see to it that the slender link, which at present exists between the producers and consumers of timber in India, is forged into a mighty chain. In other words, the Forest Department must see to it that the Economic Branch at the Central Research Institute, and the Utilisation and Working Plans Branches in the Provinces are so developed and strengthened that they will always be in a position, not merely to perform routine duties, but also to act like commercial agents in the matter of forcing upon public attention the value of the enormous wealth of which the Department is the custodian. Government do not, and the general public cannot, realise the extent to which Indian Forest Products should play a part in the life and work of the Empire. This is natural, so it is up to the Forest Department to educate them in the matter. What is required is a clear presentation of hard facts; the rest is bound to follow. The mere publication of Forest Records and Bulletins is not sufficient. They are often not even read by Officers of the Department. It is recognised by the Inspector-General and the officers at the Research Institute that propaganda work by Research Officers, in the shape of popular lectures, illustrated by lantern slides, and popular articles in newspapers and periodicals, is very essential if the Department, and parti-

cularly the Research Institute, are to be brought into close ouch with the commercial and industrial world, and if Government is to be won over to the point of view that money spent on the strengthening of the Department, especially in connection with Research, will bring in a handsome and speedy return.

The Importance of the Economic Branch at Dehra Dun.—If the Forest Department is to perform the duties referred to above, the first thing that it has to see to is that it has the necessary organisation and equipment to enable it to produce the hard facts required for the purpose of capturing public opinion, and of gaining the confidence of the Indian Legislatures. The New Site Scheme is a concrete example of what has already been effected in this direction. The Provinces can also furnish concrete examples, for instance the United Provinces at Clutterbuckganj and Burma at Rangoon. These places may be said to contain monuments of the imagination which has been displayed by various Forest Officers, and of the confidence which Government has, in the past, placed in their aspirations. It is earnestly hoped that the Economic Branch at least will not be made to curtail its programme owing to financial stringency. It will be chiefly in this Branch that the hard facts required in connection with the development of the Forest Resources of the country will be produced. To produce facts of value to the commercial world Research will have to be conducted on a commercial basis as far as possible, and not simply on a small laboratory scale as heretofore, some idea as to quantities, working costs and working conditions on a commercial basis must be obtained if any real progress is to be made. Nothing will advertise Forest Products better than the fact that the Forest Department can actually demonstrate commercial methods and processes, and can give reliable information as to the financial results that are likely to accrue from any particular undertaking. The trouble at present is very largely that neither Government nor Commercial Firms will undertake anything new which involves any risk of not bringing in a substantial profit.

Curtailment of the Economic Branch will mean a very serious set-back to the Development of Indian Forest Resources.—Once

the public become sufficiently aware of the value of the work that is being carried out at Dehra Dun, it is certain that the number of inquiries and the number of visitors to the Dehra Dun will increase very considerably. If the existing staff is not sufficiently expanded from time to time, in anticipation of this increase of work, one of two things is bound to result. Either the Investigative and Research Work will have to go by the board, or else enquiries will not be replied to in a prompt and businesslike manner. Either result will cause a serious set-back to the work of Development as a whole, and the public will once again be disappointed by the unbusinesslike methods which are so characteristic of all Government Departments. It would be infinitely better if the Research Institute, and the Department generally, refrained from doing much propaganda work (except in the Department itself and amongst the Controlling Executive and Financial Authorities), until it was certain that sufficient staff and equipment were forthcoming to deal with the situation that is likely to arise if much popular propaganda work is undertaken.

Development of the Working Plans and Utilisation Branches in the Provinces.—Side by side with the pushing of the New Site Scheme must come the extension of the Working Plans and Utilisation Branches of the various Provinces. The shortage of officers, which was a natural result of the War, had the effect of depleting both these Branches to such an extent that in many Provinces they ceased to exist, if they had ever been formed. Without a strong Working Plans Branch the surveys of Forest Resources (which are extremely important from a commercial point of view) cannot possibly be carried out with any sort of accuracy. The situation and extent of fellings, the lines of export, the adjustment of privileges, etc., are important commercial considerations in a felling scheme. The considerations have to be extremely carefully worked out by the Working Plans Officer, unless he wants his work to be scrapped after a season or two. From a commercial point of view, the Utilisation Branch comes in where the Working Plans Branch and the Territorial Branch leave off. It is essentially the Commercial Branch of the Department. In addition to the work of providing a connecting link

between the Forest Department and the Trade, the Utilisation Branch is called upon to control large Departmental felling extraction and conversion schemes. It also co-operated with the Economic Branch at Dehra Dun in helping to carry out investigations in the Forest in connection with Research problems. Territorial Forest Officers cannot possibly attend to the commercial side of forest work without neglecting their other duties, unless they happen to be in Division of small commercial importance.

A weak Utilisation Branch means a very badly served public.—There can be no doubt about the statement that the general public is, at present, badly served by the Forest Department. This is due primarily to the shortage of officers, but also to the want of specialised training in Utilisation subjects and in business matters amongst Forest Officers generally. The fact that more than ten per cent. of the sleepers used in this country are imported from America and Australia, and that the use of steel and concrete sleepers is largely on the increase is evidence of the general state of affairs as regards the use of timber in India. There are two chief reasons why this is the case, when there are cheaper and better Indian timbers available for sleepers, not to mention for other purposes for which foreign timbers are imported, *e.g.*, Oregon Pine for large squares, Maple for flooring and Australian timbers for constructional purposes. One reason is that the public is on the whole, ignorant of the kinds, qualities, quantities and prices of available Indian timbers, and of the localities where these timbers can best be obtained. The other reason is a much more serious one. It is, that it generally happens that, if an enterprising person happens to want a certain Indian timber of which he has heard, he finds that he cannot get it in the way in which he wants it. Timber dealers usually only stock the few species that are naturally immune from white ant attack. Thus the required species must be freshly felled. This means endless delay. Moreover, even if the extraction and conversion have been speeded up, there will be much further delay in connection with the seasoning and possibly the preservative treatment. In the end the enthusiast, who tries to make

use of an unknown or little known species, finishes up with buying what he can easily get, no matter whether it costs him more, or whether the timber is American or Indian. This is where the Utilisation Branch is required for the purpose of carrying out pioneer work in connection with the extraction, conversion, seasoning and preservation of less well known species, in the manner indicated by the Research Branch. Thus it all comes back to this that, unless the Forest Department is better staffed and better equipped, the commercial development of the Forest Products of India will not be possible.

The difference between Commercial Research and Commercial Business.—It must be strongly emphasised, in connection with what has been said above, that the Research Branch does not in the least contemplate setting up Forest Products businesses at Dehra Dun or other Research Stations. There is not the slightest intention that the Saw Mill should turn out sawn wood for sale, or that the Paper Mill should work at a profit, or that the Seasoning Kilns should season timbers very cheaply. Direct profits will be out of the question, where the raw material will come from all over India in the shape of samples many of which will be used for purely experimental purposes, and will never reach the finished stage. Furthermore, most of the plant and fittings are too complicated and too expensive to be of any direct commercial benefit. The extra fittings and controls (*e.g.*, automatic controls) are absolutely necessary from a Research point of view, but would be omitted in a commercial plant.

R. P. DALLEY, I.F.S.

GROWTH IN TREES.

It is only within recent years that scientific investigation has been started with regard to the actual daily and seasonal variations in the growth of trees. Dendrographic experiments form a study of absorbing interest and, although such experiments have never been attempted (to the writers' knowledge) in India, the subject is one which must interest Forest officers in all parts of the globe.

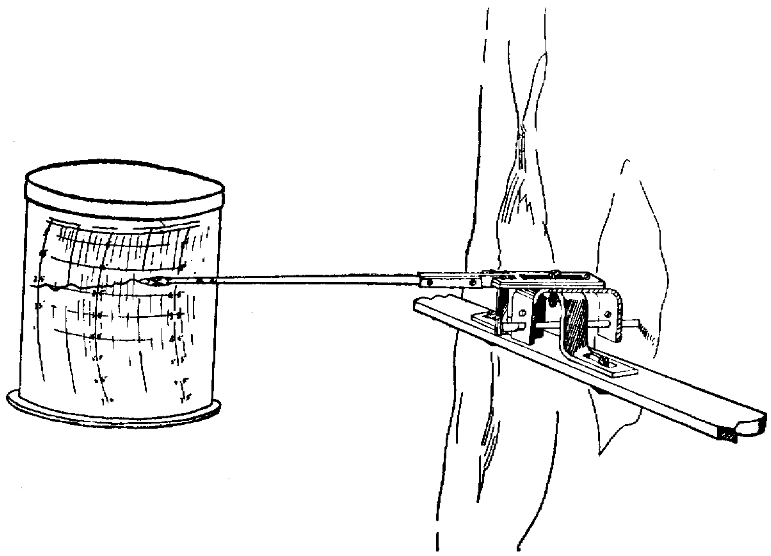
Such results as have been obtained up to date come from America and for these results the science world is indebted to Dr. D. T. MacDougal who has devoted a great deal of time in the last few years to the study of the daily and seasonal changes in the volumes of standing tree trunks and to the construction of various instruments for accurately recording these changes. The object of this article is to give a brief account of his investigations and some of the more interesting conclusions he was able to draw from those investigations.

To those who hanker after definitions, a tree may be defined as a tall cone of wood terminating in leafy expanses. The base of the cone is sub-divided into myriads of rootlets, through the surface of which, soil solutions enter the tree system and the water passing up through the trunk and branches, is transpired from the leaves. The actual trunk of a tree is composed largely of dead cells, but enclosing it is a thin sheet of spindle form cells known as the cambium cells, which, in the growing season, enlarge in thickness and divide lengthwise, thereby increasing the girth of the tree to an infinitessimal degree with each successive enlargement. External to the cambium layer are sieve cells, bast fibre, cork cells, etc., and the whole is enclosed in the bark which varies widely in structure in different species.

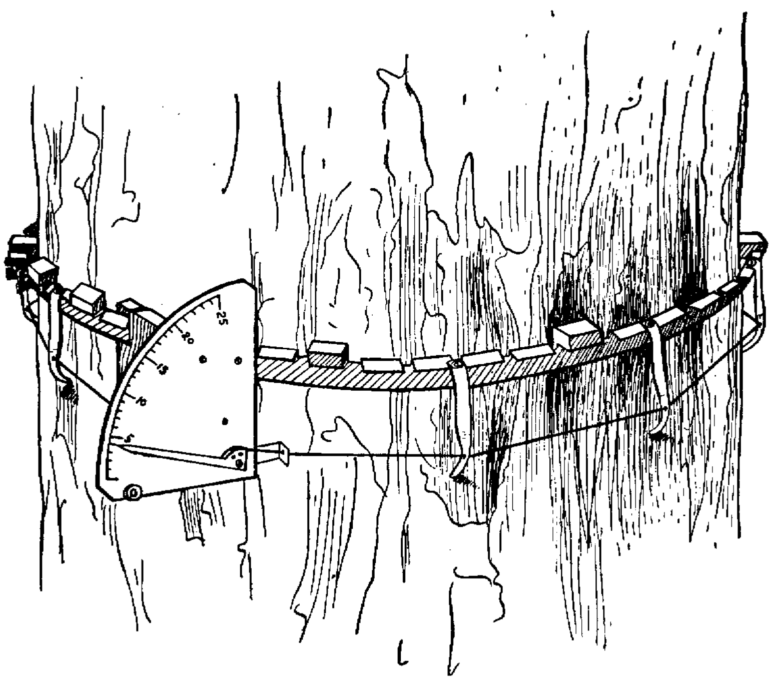
As already mentioned, the greatest amount of increase or change in volume is that which results from the multiplication of the cambium cells. The colloids of these cells are practically never in a stable condition but are always adjusting themselves to an ever changing environment, more especially with regard to the water they contain. All plants, except submerged forms, are continually losing water from part of their surfaces while at the same time, water is entering the system through the absorbing surface of the roots, and as a consequence the volume of the tree increases or decreases according to the balance between gain and loss.

These changes in the hydration of the protoplasm in the cells results in the conversion of the materials in the cell sap into the condition characteristic of living matter.

Both processes, the one of absorption and the other a shifting of equilibra in chemical composition cause an increase of the



Improved dendrograph lever set. The inner end of the quartz rod rests on a prepared surface of the bark. Any movement of this rod is at once recorded on the revolving drum.



One form of the dendrometer. A slight enlargement has taken place causing the flexible arms to be pressed outward. This has pulled on the wire to such an extent as to cause the indicator point to move from zero at the bottom of the scale to " 4."

volume of the protoplasm and an enlargement of the cell-mass of which it forms a part. This is what is commonly known as growth.

Now any measurement of the increase or variations due to growth in the cambium layer will at the same time include the variations in the volume of the woody cylinder which is also the conduit through which liquid passes from the roots to the crown. Such trees as the birch, with 200,000 leaves, are reputed to transpire as much as 400 litres in a single day. The trunk of a tree may, in fact, be compared to the supply hose of a fire engine coupled to a hydrant. When the pressure from the mains is enough to supply water faster than it can be pumped out, the hose is distended. When the engine tends to take water faster than it is delivered by the hydrant, the hose becomes deflated. In the case of trees, however, the conduit is not a simple pipe or a set of pipes, but is made up of a series of vessels through which the water passes under capillary action and which may be only partially filled with water so that when water is withdrawn from such a system faster than it is taken in, the resulting changes are very complex in character. These facts were well considered by Dr. MacDougal when he instigated his experiments in the measurement of growth in trees in 1918 and a new technique with specially designed instruments was found necessary for the analytical study of the changes in volume of these massive organs. Such instruments were designed and afterwards improved on by the investigator and include:—

1. *THE DENDROGRAPH*, which is an instrument for making continuous records of the variations of tree trunks. The essential feature of this instrument consist of a floating frame of metal of low temperature coefficient which is placed round the tree trunk, and the variation in distance between a contact rod on one side of the trunk, and of one end of a rod on the other side, is traced by a pen on the free end of a lever, on a sheet of paper carried on a revolving cylinder.

Such measurements are in terms of the diameter. The illustration will give a general idea of the form this instrument takes.

A DENDROMETER, which is an instrument of simple design and non-expensive construction which is placed round the trunk of a tree and the size of the trunk read on a dial from time to time. The essential parts of this instrument are an encircling wire engaged with a number of bearing levers. One end of the wire is anchored and the other is attached to the short end of a lever, the free end of which moves over a scale giving readings of the size of the trunk, in terms of several radii or of the circumference.

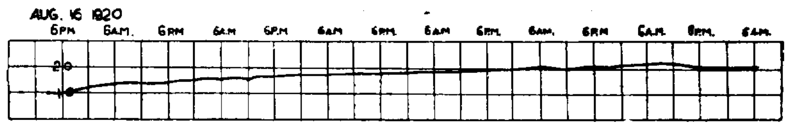
It is not proposed in an article of this nature to go into lengthy details and descriptions of the methods of using these instruments but merely to give a short account of the work done up to date and of the extraordinarily interesting facts which have come to light.

1. In the first place, the period in which enlargement of trunks takes place has been proved to be comparatively brief, even in places where the season is of indeterminate length.

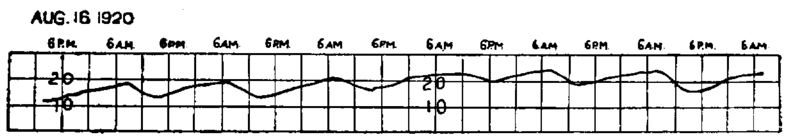
2. The trunks of all trees measured, show a daily variation in size, by which the maximum is reached shortly after sunrise and the minimum at a time after noon, dependent on external agencies. These variations appear to depend upon the water balance in the woody cylinder and are greatest in the seasons in which water loss from the crown is greatest and least in the cooler and damper seasons.

Measurements of variations in the woody cylinder are made by boring holes through the wood of the last two years, and arranging the contact rod of the dendrograph to bear on the wood formed two years previously.

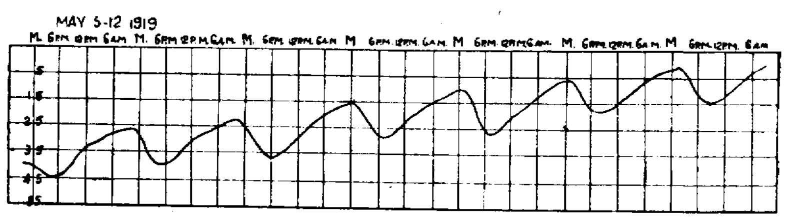
3. Growth in the terminal buds with the resultant elongation of leaders and branches begins in many trees some time before enlargement of the trunk takes place. The period separating the two may be no more than a week, as with *Quercus agrifolia*, but has been recorded to be as much as 10 or 12 weeks in the case *Pinus radiata*. In certain rare cases, more especially with the Parry Spruce (*Picea Parryana*) and Douglas Fir (*Pseudotsuga Douglasii*), the trunks were enlarging at a time when the buds were in a very early stage of development. In the single case in which



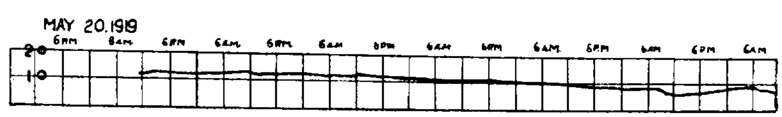
Dendrographic record of a California oak, showing a steady increase denoting growth, with practically no daily variations.



Dendrographic record of the variations in growth of a Monterey pine. Note the daily variations giving a wavy effect, but at the same time there is a steady increase in actual growth.



Dendrographic record of an ash tree, showing maximum daily variations, due to low relative humidity and high transpiration during the mid-day period. At the same time there is a steady increase in actual growth.



Dendrographic record of a pine tree, showing a gradual but distinct *decrease* in growth due to very hot dry weather.

dendrographs were attached to a pine tree simultaneously at one metre and 8 metres from the ground, growth began coincidentally at the two places in 1920, but in the following year enlargement at the higher point commenced a few days before any action near the ground had begun.

4. Daily variations in the diameter of a trunk which has ceased to grow for the season amount to one part in 1750. That a large share of this variation is due to changes in the hydration of the living cells is proved by the fact that in the woody cylinder of the trunk internal to the growing layer, the variation drops to 1 part in 8,750 of the diameter

5. The actual daily change in volume calculated on the basis of a conical trunk 18 metres high and 35 cm. in diameter at the base amounts to 400 cub. cm.

The greatest daily equalising variations were shown by *Fraxinus*, *Pinus*, *Picea* and *Juglans*.

Smaller variations were displayed by *Populus Platanus*, *Fagus*, *Quercus* and *Citrus*. No available facts furnish the basis of an adequate explanation of such differences.

6. The final effect of rainfall shown within a few hours is to accelerate growth, but it has been repeatedly observed that actual shrinkage may take place while the rain is falling.

7. Irrigation of the soil round the roots of a pine tree when the moisture contents of the soil was less than 6 per cent. was followed by progressive enlargement at the base of the tree and at a point 8 metres higher, within 24 hours. The distance from the absorbing surfaces of the roots was not less than 3 metres from the lower instrument and 11 metres from the upper instrument. It seems hardly credible that the water could have conducted through the complicated series of cells in the roots and trunk in so short a time.

Nevertheless results obtained in a similar irrigation test with oaks were even more startling. *Within two hours*, the dendrograph which was in contact with the trunk at a distance of at least 3 metres from the absorbing surfaces of the roots showed a steady enlargement. This action may be directly connected with the fact that vessels in these oaks were numerous and large

Such rapid enlargement is nevertheless almost unbelievable but the dendrographic records leave no room for doubt.

Such then are the main points of interest as shown by the highly sensitive instruments used in these experiments.

Space does not allow a full and detailed account of the progress of all the experiments during the actual period of measurement but it is hoped that the illustrations will explain matters for themselves. The four dendrograph records shown were picked out of many, as typical of the variety of the form they assume and as showing the normal as well as the extremes in the daily variations. The above remarks are not based on the measurement of a few isolated trees but from the well-considered conclusions arrived at after several years of investigation with hundreds of species in different parts of America.

Conifers and broad-leaved species both came in for their full share but no startling differences are recorded in the results obtained from these two sections. The readiness of reaction of the broad-leaved species to an increase of soil water-supply, and the shorter period of enlargement, and small relative total of these species, were however generally noticeable.

Such then are the results of these investigations to date. The description is of necessity very brief and inadequate, and those who are interested in this subject, and who would like to study the subject in detail, should refer to the pamphlet published by the Carnegie Institution of Washington and entitled "Growth in Trees," by Dr. D. T. MacDougal.

H. TROTTER, I.F.S.

[The following note has been added by Dr. H. P. Brown, Ph.D., the eminen American authority on wood technology, at present officer-in-charge, Wood Technological Section, Forest Research Institute, Dehra Dun, in order to bring out one or two points of interest.—HON. ED.]

Dr. MacDougal's paper on tree growth is of more than ordinary interest, coming as it has as a sequel to certain histological studies in this field which were conducted at Ithaca, N.Y., during 1910—14, inclusive, mention of which is made in his paper, and which are now being continued at the New York State

College of Forestry, Syracuse, N.Y. A brief discussion of the results achieved in this latest contribution to the subject may not be out of place.

It would seem, that the argument as to seasonal rhythmic growth in trees has been finally settled as cambial activity, appears to be governed purely by environmental factors prevailing at a given period which enhance, inhibit, or preclude growth altogether. A tree enlarges only when conditions permit of it, irrespective of the time of year; nor do the growth periods of successive years necessarily overlap. There is no inherited tendency toward dormancy and activation of the cambium at specified times, and the problem is rendered the simpler thereby since growth dynamics can be reduced to understandable physical terms and the mysterious and unexplainable eliminated altogether.

The dendrograph had likewise established the presence of diurnal growth pulsations, which attain a maximum in the early morning and a minimum at mid-day, or in the early afternoon, when the temperature of the trunk is at the highest. This apparent anomaly is to be explained in that the water absorption by deep roots is little or at all inhibited by the cooler temperatures of the night hours, while the transpiration rate is altered markedly thereby. The meristematic tissues become fluxed with water at night, a condition which is relieved by ensuing transpiration the following day. If this reasoning is correct, it follows that water plays a more important rôle in tree growth than temperature; owing to the insulating property of the bark, night temperatures are not such as to inhibit growth materially; it is retarded during the higher readings of mid-day, not from excess of heat but through reduction in available water.

It is to be noted in the above connection that pulsations may occur without permanent increment, in which case the daily maxima and minima wholly compensate each other. Or actual shrinkage may take place over a given period and the apparent gain of a preceding cycle be thus wholly negated. Finally, some trees exhibit no seasonal growth whatsoever for a given year a condition which sets at naught the method of estimating

the age of trees through ring counts at the base. Where actual gain is registered by the dendrograph I would caution the reader in interpreting it wholly in terms of wood increment. Of necessity in measuring growth by cell division, the arms of the instrument must be set without the last formed periderm owing to the desiccation of the deeper lying, living tissues which would otherwise ensue. The gains registered represent not only the product of the activity of the true cambium, that is, the new xylem and phloem, but the cork cambium as well in terms of additional periderm. Different tree species vary greatly in the manner, extent and rapidity of periderm formation ; in addition the wound stimulus arising through the removal of the outer bark would undoubtedly result in an increase in the number of cork cells where the last formed periderm was exposed. It would seem desirable in some instances at least to correlate the dendrograph readings with accurate histological studies ; measurements of increment borings can scarcely replace these in making accurate deductions.

The fluctuations which occur when the dendrograph is set directly on the wood itself can only be explained in that the moisture content of the woody tissue or portions of it falls below the fibre saturation point at times during the twenty-four hours. The author suggests that the water thus lost is withdrawn from the wood either by direct outward exit through the bark, a condition which seemingly takes no account of the imperviousness of the cork to the passage of water, or upward through the branches and out through the leaves, possibly in both ways. It is inconceivable to consider that the volume of a lignified tissue is influenced by a loss in turgescence of such living cells as it contains (wood ray and vertical parenchyma in the sapwood), cells, the walls of which are more or less lignified and surrounded by thick-walled, strongly lignified prosenchymatous tissue, nor can the presence of air bubbles in dead lignified cells (prosenchyma), though their surface tension varies with changes in the amount of water in the tissue, have any appreciable bearing on shrinkage. I am of the opinion that the diurnal pulsations registered in the wood itself are traceable to varying moisture content in prosen-

chymatous cells (which die and lose their content the season of their formation) when the water in the walls of such mechanical elements falls below the fibre saturation point, shrinkage takes place, even though the neighbouring living parenchymatous tissue in the sapwood is still fluxed with water. The irregular distribution of moisture in the last formed annual layers would explain the phenomenon of shrinkage in the wood body proper.

The recent contribution of Dr. MacDougal works a distinct advance in a field of research fraught with many obstacles, some well nigh insuperable. His results are timely when correlated with those obtained from histological studies, supplying as they do many links of information which assist materially in the marshalling of the scientific data in this immediate field. In a country such as India with wide fluctuations in temperature and rainfall, with a range of tree species second to none in the world, the proper understanding and interpretation of tree growth would play no small part in the silvicultural practice of the future. There is a dearth of information on the growth of Indian trees, and it is desirable that growth studies be instigated in the near future to supply the much-needed information.

H. P. BROWN, PH.D.

THE EFFECT OF WIDE SPACING IN TEAK PLANTATIONS.

In view of the recent correspondence in the *Indian Forester* on the subject of spacing in teak plantations the following note may be of interest:—

In the course of recent sample plot work I was able to compare a plot originally planted 9′ × 9′ in 1914 (now 9 years old) with a plot originally planted 6′ × 6′ in the same year.

The following points are of interest :—

Forking.—Approximately 19·25 per cent. of the stems in the 9′ × 9′ plantation were forked as compared with 6·5 per cent. in the 6′ × 6′ plantation. This made the thinning in the 9′ × 9′ plantation extremely difficult owing to the large number of forked trees and the greater importance of each tree in the general stocking. In the 6′ × 6′ plantation, owing to the closer

stocking, forked trees could almost without exception be cut out in the ordinary course of thinnings without causing any unevenness of stocking.

Growth. (a) *Height.*—The height growth of the sample trees taken in the 2 plots compares as follows:—

Diameter Inch Classes.	Height.	
	6′ × 6′	9′ × 9′
4″	41·5	40·9
5″	47	44·8
6″	51	48
7″	53·7	50·9
8″	...	53·1

(b) *Diameter.*—The stems in each plot were classified as follows:—

Diameter Inch Classes.	Percentage of stems.	
	6′ × 6′	9′ × 9′
3″	11·4	5
4″	38·5	23
5″	33·5	35
6″	13·6	25·5
7″	2·75	9·8
8″	0·25	1·7
	100	100

This shows that the diameter increment of individual stems in the 9′ × 9′ plantation has been greater than in the 6′ × 6′ plantation while the height growth of dominant trees is much the same. At the same time it should be remembered that according to our latest ideas, the 6′ × 6′ plantation should have been thinned 3 years ago at the age of 6, and had this been

done there can be little doubt that there would not have been much, if anything, in favour of the 9′ × 9′ stocking.

Summary.—The tendency to forking in the wider spacing more than conteracts the slight increase in diameter increment which may possibly be claimed for the 9′ × 9′ plantation. Of course these figures are insufficient to establish any theory, but they tend to confirm in a most striking manner the opinion expressed by Mr. Bourne in his Working Plan for Nilambur. On page 53 of Vol. I of that Working Plan, Mr. Bourne summarises the case for close planting. He concludes as follows:—

"The close spacing of 6½′ × 6½′ and 6′ × 6′, adopted in the past, resulted in such straight undivided stem, that it should be departed from in the future, only for silvicultural, and not economical reasons. Such economy may well prove to be false economy in the end." In view of the tendency towards a wider spacing which exists now in Burma, I emphatically agree with this opinion.

H. R. BLANFORD, I.F.S.

REPORT ON KARAI (*STERCULIA URENS*) TAPPING.

GUGAMAL RANGE, MELGHAT DIVISION, C. P.

It was desired to collect one maund of gum *karaiya* for which purpose an area in the vicinity of Koha Forest Village having sufficient number of the desired trees was selected. The experimental tapping of *karai* trees was started from 19th January, 1922, and completed on 30th January, 1922. Only two methods of tapping were tried as described below :—

1st Method.—In this case the bark of the tree was cut out and wood exposed with the help of 2 chisels made especially for the purpose. This is divided into 4 classes according to the shape of the notch as shown in the marginal sketches below :—

CLASS I.—One 18″ × 4″ notch, 2′ above the ground and only on one side of the trees.

CLASS II.—4 oblong notches. One on each side of the tree and extending over about one-quarter of its girth. Lowest notch being 2′ above the ground.

CLASS III.—One notch, on one side only, 3′ above the ground.

CLASS IV.—A 6′ wide band of the bark removed from all sides, *i.e.*, a light girdling.

2. The second method was to wound the tree. The wounds were inflicted at a short distance apart with a sharp pick point as suggested in the Chief Conservator of Forests' letter. Trees tapped under this method are put under Class V for the purposes of description and record.

The work was done by coolies engaged on a daily wage of Re. 0-5-0 and the total cost of the experiment amounts to Rs. 69-6-0 as detailed below :—

	Rs.	a.	p.
Cost of 2 chisels made locally	2	0	0
Cooly wages	65	0	0
Carriage of gum from Koha to Chikalda ...	2	6	0
Total ...	69	6	0

This amount does not include the cost of supervision. A statement was made which gives the full details of the trees tapped and gum obtained. An abstract taken out from this statement is given below :—

Class.	No. of trees tapped.	Gum obtained in tolas.	Average per tree in tolas
I	40	907	22
II	30	861	29
III	30	391	13
IV	60	1,661	28
V	50	843	17
Total ...	210	4,663	

It would appear from this that Classes II & IV have given best results, but whether they are detrimental to the growth of

trees or not, is yet to be seen, and if the trees do not lose their vitality after the rains are over, then, both of these are suitable methods for tapping *karai*. They give big fine clods of white gum, which will essentially enhance the quality of *katira* and its value, besides a further advantage of easy collection. In trying these methods the following points will be found useful :—

(*a*) The bark should be given a straight clean cut which can be done easily with chisels.

(*b*) The gum should be removed after it has dried fully; or else some of it will stick on to the cut surface of the edge, and, unless shaved off, will stop the passage of further tears. If, however, there may not be enough time to allow the gum to dry, then the edges must be renewed, after each collection, which can be done economically, by cutting off a thin slice of the bark edgewise along with the gum at the time of its collection. This edging will not only keep the passage of further tears clear, but will also stimulate their rush out.

CLASS V. is a good method for such cases only as would shoot out continuous tears profusely. Since it is noticed, that intermittent tears, with a slow rush, dry before the dropping is commenced, the mouth of the wound thereby gets clogged, and the passage of further tears is blocked once for all.

The gum in this case is not as white as in the preceding two cases, and its collection also is by no means easier.

The following are further observations, made during the course of this experiment :—

(*i*) Trees situated on northern or eastern slopes give more gum than those situated on the southern or western slopes.

(*ii*) Notches cut out on the northern or eastern sides of the tree give better results than those on the other two sides.

(*iii*) Trees growing on loam or alluvial soils give more gum than those on rocky or precipitous slopes.

(*iv*) Trees in shady places exude more gum than those standing in the open.

(*v*) If wet or fresh gum is collected it loses about 15 per cent. of its weight in drying.

(*vi*) Collection should not be done too often and too early after the tapping, as this simply adds to the cost, at least a month's time should be allowed, before the first collection is made, for the gum to trickle out and dry properly. Subsequent collections may be made once a month.

About 58½ seers of gum were collected out of this, about 8 seers of weight were lost in drying, while about ½ a seer was lost in weighing, storing and carrying. The cost of the experiments amounted to Rs. 69-6-0 for the yield of 50 seers of gum, and the average cost per seer came to Re. 1-6-4. The cost would have been much cheaper but for the pressure of time, and also for the reason that the trees were scattered far apart.

Fifty seers of gum were sent up instead of 40 seers. These extra ten seers were collected under the then D. F. O., Mr. R. T. Jenkin, I.F.S., orders were given to compensate the weight of bark and wood chips that were mixed with it: with the exception of this admixture, which could not be avoided for want of proper collecting knives, the gum is quite pure and dry.

N. B.—The trees tapped under Classes II & IV have neither lost their vitality, nor suffered in any way. Wounds caused by the notches are healing up.

MD. ABDUS SALAM,
Forest Range Officer, Gugamal Range.

AMERICAN FOREST REGULATION

BY THEODORE SALISBURY WOOLSEY, JR. M.F.

Published by Messrs. Chapman and Hall Ltd., London.

Price 18 *shillings.*

Mr. Woolsey defines Forest Regulation as that branch of forestry which concerns itself with the organisation of a forest property for management and maintenance, ordering in time and place the most advantageous use of the property, with the aim of securing a sustained yield. It is, therefore, practically what we mean by "regulation of the yield."

The book is divided into two parts and has serial appendices but as Part I is by Mr. Woolsey, Part II by Mr. H. H. Chapman and the Appendices are translations from the German or separate notes in themselves, it really consists of two separate though connected books and a series of translations and articles all bound together. Owing to this arrangement it is necessary to review the book in parts.

Part I which is entitled Policy and Theory of Regulation contains 9 chapters with the following headings: Chapter I.

Introduction to Forest Regulation; Chapter II, Background of a Regulation Policy and a Sustained Yield ; Chapter III, Management and Administration sub-divisions ; Chapter IV, Rotations—Technical, Silvicultural and Economic ; Chapter V, Financial Rotations ; Chapter VI, The Normal Forest ; Chapter VII, Regulating the Cut ; Chapter VIII, (A) Volume Methods of Regulation ; Chapter IX, (B) Area and (C) Area—Volume Methods of Regulation.

After a preliminary account of what Forest Regulation really is, Mr. Woolsey goes on to point out the necessity of a definite regulation policy and adduces many trite arguments in favour of a sustained yield.

He states that America after cutting or burning half her forest resources is still felling what is left, more than four times as fast as it is growing. The result of this is self-evident and from it he deduces the importance of research work regarding increment and rates of growth, and though he admits that there must be a balance between policy, economic conditions and research he adds that research is often so all important that it may come first, and he regrets the present tendency to put too much stress on economics—an opinion which has been so often expressed all over the forest world in recent years. We all realise the vast importance of the economic side of forestry, but it is ultimately dependent on the regeneration and rate of growth.

The arguments in favour of a sustained yield are excellent but Mr. Woolsey is no blind upholder of the policy, and he gives perfectly good examples of cases where the sustained yield principle would not be good policy. One sentence we must quote to our shame, " Some administrators (British India is an example)" he says " desire to make a good financial showing ; consequently they may be led to cut more than the forest produces." It is beneficial sometimes to see ourselves as others see us. He adds," The working-plan officer must be enough of an idealist to combat the every day arguments of the opportunist administrator."

The whole of Chapters IV to IX are very detailed and technical. All the best known formulæ for yield calculation are analysed and compared. While we agree in the main with wha

is written, these are points where many will join issue. There are, by the way, some misprints in the formulæ on page 61. Towards the end of these Chapters, Mr. Woolsey brings out some important points, "There is another important point in policy to be considered, in weighing a method. How much accuracy is justified in extensive conditions? To my mind a crude method that will give rule of thumb results is sufficiently accurate . . ." He then goes on to point out that a rough regulation of the yield and sound silviculture is probably the soundest policy over large areas where the forests are often abnormal and where the yield calculation can at best only be a guide.

Part II, entitled Correlation of Regulation and Growth in Extensive American Forests, contains four chapters. The cutting Cycle as a Determining Influence in American Forest Regulation; The Application of Regulation to American Forests; The Problem of Sustained Yield; Regulation of Forests Composed of Even Aged Stands. Although it contains a good deal of theoretical matter, it is largely the practical application of the theories in Part I, to the existing irregular crops of America, often composed largely of overmature trees.

Mr. Chapman looks at the whole problem from a new point of view, and though some of his theories are unconventional, they certainly offer ideas to those who have to deal with large areas of virgin or more or less virgin forest. Apparently in America they have also found that plans, based on the fact that one valuable species occurred among a lot of inferior species, were liable to be much upset by the increasing value of the former inferior species for he lays down that "in cases where originally a single species is merchantable in a mixed stand, it is almost inevitable that later on, the remaining species will become merchantable. In this case, the *growth* required will be the economic growth of markets and stumpage values. The first cutting cycle cannot be based solely on the period required to produce an equal yield of the given species, for the chances are that this single species, as a result of cutting in a mixed stand, *will decrease in numbers and growth by suppression.* The cutting cycle may be based on the combined factors of growth of the species in question and future merchant-

ability of the remaining species. The total growth of the stand not that of a fraction of it, is the only safe basis of regulation." While in India we wish to take special steps to prevent our valuable species decreasing in numbers, there are few who will not admit the truth of the last sentence quoted.

The Appendices give a useful account of the Forest Management in nine European States, and a discussion on financial rotation besides other matter of minor importance.

The book contains a tremendous amount of useful matter. Our criticism of it is however that it is not always expressed very clearly and the whole book seems rather disjointed.

So technical are many of the discussions, that it necessitates careful and repeated reading to realise exactly what it is all about. We consider this detracts from the merit of the work, in that it will not appeal to the ordinary forester.

S. H. H.

THE BURMA FOREST MAGAZINE.

The first number of this new Magazine has been received and read with considerable interest. The editorial explains in a few words the origin and objects of the Magazine which is the outcome of the formation of the original Burma Forest Club. This club has been reorganised and is now known as "the Burma Forest School (old students) Club" and this Magazine is to be its mouthpiece. Its chief object is to act as a means of intercommunication between the members of the club and between the branches of the club which are distributed throughout the various Forest Divisions of Burma. With this end in view, the Magazine will contain many items of interest under the heading of club notes, school notes, domestic occurrences, notifications and office orders, correspondence, etc., and in addition to these there will be articles by members of the club and others, extracts, reviews, etc. The number under review is excellent reading, and the apologies of the editor in his explanatory note for its deficiencies are hardly called for. The articles are in the main written by Range officers and others of the Subordinate Service, and this fact in itself is sufficient to make this Magazine, a publication of

special interest not only to Club members, but to all Forest officers, throughout India and Burma, and if Burma's budding authors come forward in future with contributions of the same standard as appear in this issue, the Magazine should have no difficulty in maintaining the position to which it aspires. When reading these articles it occurs to one to wonder how it is that so many new contributors have suddenly sprung to light, when it is well known that the *Indian Forester* for many years past, has been calling loudly for original articles with very little response from Subordinate Forest Officers. Is it that these many authors have been hiding their light under a bushel all this time and were alarmed at the prospect of seeing their literary efforts in print n the major periodical? If so, it is time the *Indian Forester* looked to its laurels and it should take this opportunity of inviting contributions from these shy members of the Burma Forest Service. Otherwise Provincial offsprings such as this Magazine and the Madras Forest Magazine will be getting all the cream, and then, "what about poor old Father"?

In the meantime we wish the Burma Forest Magazine all good luck in its career so well started.

H. T.

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INDIAN FORESTER

JULY, 1923.

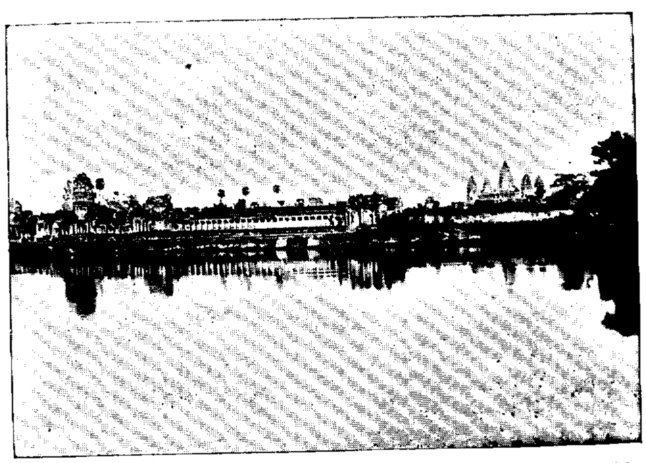
RANDOM NOTES FROM EASTWARDS ROUND.

I am haunted on my travels by public holidays, not that I wish to imply that the populations that I happen to visit burst into general rejoicings at my arrival, but just that my starting and landing always seems to fall on a Sunday or a Bank holiday. This trip has been no exception to the rule. We left Colombo on a Bank holiday, so that it was only with difficulty that my companion and I could raise enough money to buy our tickets. Next we reached Penang on a Sunday, and left after a few hours, so that my impressions of the place are not worth recording. At Singapore we landed at dusk and left at dawn, so that we were only able to spend a few hectic hours wildly trying to buy plates for the camera, and a few necessaries. The bar at Raffles did not seem to promise sufficient novelty to be worth spending money on it.

Thence an uneventful passage to Cape St. Jacques, after which a tiresome four hours up a winding river lined with stunted

1. *Indaing* type of forest, Tay Ninh Province, Cochin China.

2. Floating village of Kompong Chnang, Cambodia.



Photos by W. A. Robertson, I.F.S.

3. View of Angkor Wat.

mangroves up to Saigon where we found the best hotel crammed and had to find rooms in the second best. Ugh! A very rapid glance at the rooms impressed on us the necessity of getting away from the place at the very earliest, so after much chasing about in the most exhausting climate in Asia we managed to hire a motor to enable us to catch up the river steamer for Angkor at Pnom Penh about 130 miles up the Mekong.

Of all the bad nights I have spent in the East I think that one at the Hotel—was the worst. The band of the hotel café was in full blast when I went to bed, and remained so till nearly 2 A.M., the first violin instilling a greasiness into his music, thoroughly in keeping with the climate. At 2-15 two belated revellers indulged in a slanging match in the Street below, then a pause during which a rat in the woodwork gnawed with a noise like a sawmill. 2·35, an hilarious party returned to the adjoining rooms, recounting the evening exploits at the top of their voices, after that more rat. 3·00, some human fiend tested his motor bicycle up and down the neighbouring streets, with the exhaust cut-out opened full, and when he at last died away, another fiend started a car and raced the engine, while sand flies invaded the mosquito net. At 4 A.M. the rat finished his job, and I fell asleep exhausted only to wake up at 5·30 in a damp chill, with early carts going their rounds.

By the time we got away at 11 we were quite prepared to go back to the ship and give Angkor a miss, if the motor had failed to turn up. Once in the motor, all went well. Up to the border of Cambodia the country is extraordinarily like parts of Lower Burma being mostly paddy fields, with a few low laterite ridges where some misguided people have planted rubber.

The roads are excellent, well metalled, well kept up, and well labelled for motoring. Within the Cochin China boundary we passed through a few patches of forest, chiefly semi-evergreen type worked as coppice with standards, alternating with patches of very open dry forest, looking like very poor *indaing* forest in Burma (photo 1). Naturally, from the motor, one could not see much of the inside of the forest. With the exception of one hill near Tay Ninh, which rose with all the abruptness of Mt. Popa in Burma, the country was dead flat as far as one could see.

After crossing the Binh Soi, on a primitive but well run ferry. we crossed the boundary of Cambodia. From there, for many miles, the road run for miles through marshy land covered with a low shrub which I could not identify, varied with pachtes of paddy land, but it is obvious that the land is not sufficiently drained for any forest growth. On patches of higher ground we passed a few villages, most of them very well kept and well built As usual, all the best houses seemed to be owned by Chinese, who have all the trade of the country in their hands.

At the headquarters of the various districts the Government buildings and rest houses put to shame anything of the sort in India. All were well built with neat compounds and looked clean. There was none of the look of shabby decrepitude which one associates, for instance, with a dâk bungalow in the plains in, India. Right on to the Mekong, where there was a motor ferry boat and wide concrete ramps for motors, the road was in first class condition. It is true there did not seem to be much heavy cart traffic on it, but on the other hand there were no herds of cattle lying on the road to work the metal loose, I imagine that "L'Administration" has well defined views as to how far the private individual may damage works of public utility for his own convenience, and sees to it that these views prevail. Anyhow, as we did our 25—30 miles an hour with perfect comfort, I thought of certain roads in the U. P., where 15 miles per hour is the limit, and I envied Indo-China.

So to Pnom Penh, a biggish town on the Mekong, corresponding roughly to Mandalay in position, and resembling it strikingly in every particular. The hotel there was clean compared to our horror in Saigon, and the general atmosphere of the place restful.

The sights of the place are the museum, the palace, and the *Pnom* all of which we visited like good tourists. The museum and art school are like any other, and the palace is a disappointment. The latter was designed by a European on approved local style, brand new and correspondingly ugly. Perhaps with 50 years of good conscientious neglect, it may become passable, but I fear "L'Administration" will prevent that. The crown jewels

which should have commanded our respect, were of regal ugliness and the late king seems to have had an inspiration in incongruity, when he applied a diamond cockade (like a coachman's in design) to a bowler hat.

The silver pagoda with a gold *gaudama*, and a floor of silver sheets was not impressive, and certainly was not to be compared to the Arakan pagoda in size or appearance.

From Pnom Penh to Angkor the country is pure Lower, Burma. For eighteen hours the launch goes up the Tonle Sap into the lake of that name. It is a replica of the upper part of the Rangoon river, even to the flooded forest along the banks and the all-pervading faint smell of "*Ngioc-man*" which is the Cambodian equivalent of "*nga-pi*". The flooding up of the land is on a much bigger scale than in Burma, and floating villages are quite a feature (photo 2).

From the launch to the dry ground, we had an hour in a sampan through regular "*laha*" forest, of which the large trees seemed to be exclusively *Barringtonias*, and then forty minutes in a car through one of the prettiest villages I have yet seen in the East to the rest house at Angkor, facing the famous *Wat*. The "Sala" as it is called, is clean and comfortable and well run.

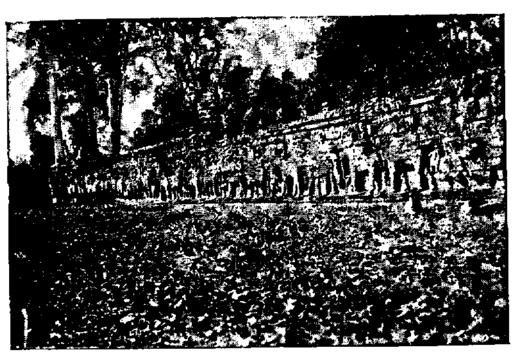
As to the ruins, *i.e.*, Angkor Wat, Angkor Thom, and the surrounding smaller temples, the only thing that can be said about them is that they are stupendous. No description can do justice to the splendid planning and extraordinary decoration, to say nothing of the size of them. One can form some idea of the labour expended on them, when one thinks that no mortar has been used in the whole group, every stone has been ground true to fit its neighbours, and in the *Wat* alone, the bas reliefs in one ring of cloisters, is nearly half a mile long (photo 3). While Angkor Wat is undoubtedly the most majestic and best preserved of the ruins, those of Angkor Thom interested me more. The *Bayön* with its fifty-four remaining towers, each carved into the four colossal faces of Brahma, strikes one as having been designed by some genius on the point of going mad, while the bas reliefs there showing the life of the old Khmers are absorbingly in-

4. Staircase in Angkor Wat.

6a. Bas-reliefs at Angkor Thom.

5. Towers of the *Bayon.*

6b. Bas-reliefs at Angkor Thom.



Photos by W. A. Robertson, I.F.S

7. Frieze of elephants, Angkor Thom.

teresting (photos 4, 5 and 6). All phases are dealt with, fighting, hunting, fishing, boating, cooking, even down to such homely incidents as a man having his head disinfected by his loving spouse. On a neighbouring building I came across a recently unearthed panel, showing elephant catching. It seems that they noosed in open forest, after the elephant had been brought to a standstill with *koonkies*. The look of indignant surprise on the face of the elephant over whose foot the noose has just been passed, was quite an artistic triumph. Stalking deer, with the use of a stuffed head as a disguise, seems to have been a common way of doing it, as it occurs in several places. Unfortunately these scenes were so placed that I could not photograph them.

The splendid frieze of elephants, in the front of what is supposed to have been the palace, depicts a royal hunt on an heroic scale, but unfortunately the weather has damaged it badly. All the same, the incidents are stirringly shown, a tiger clawing an elephant, a mahout having trouble with his beast, and an elephant retrieving a dead barking deer (photo 7). In its prime it must have been well worthy of a palace.

The ruins outside Angkor, still remain buried in forest. *Tetrameles nudiflora* is the species which is found most commonly growing actually on the masonry, and reaches a very large size, with an enormous spread of roots. In the rest of the forest the most common species are *Dipterocarpus* both *alatus* and *turbinatus* and others and a *Lagerstrœmia* which I took to be *L. calyculata* from its bark. This latter species I also saw, growing in pure groups in a forest near the border of Annam. Bamboos were very scarce, the commonest one being a climbing species which I could not place, but which I think was a *Gigantochloa*. *Licuala* and various canes were common. The old fashioned Burmese torch of *Licuala* leaves dipped in wood oil, is still in regular use in this region and we attended a Cambodian dance at night on the causeway of the *Wat*, which was lighted up exclusively by this means and very picturesque it was.

The return journey to Saigon was uneventful. On arrival, I visited the headquarters of the Forest Service of Cochin China and received a very kindly welcome from M. Meslier, the Inspecteur

Adjoint. Our time there being limited to the three days before the boat sailed, it was impossible for me to see any of the more important timber reserves, but M. Meslier arranged two motor excursions for me at what must have been considerable inconvenience to himself, and was good enough to accompany me.

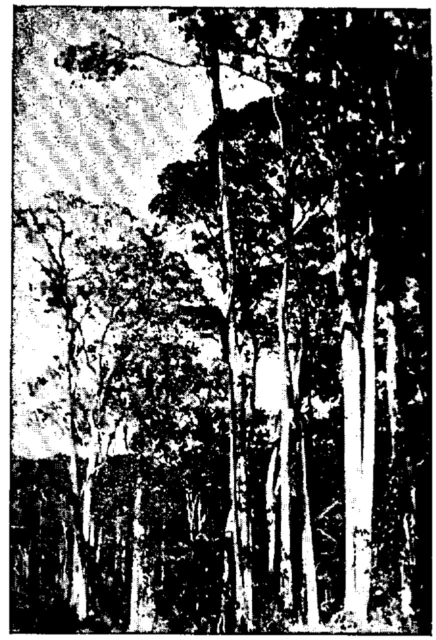
The first day we left at 4-45 A.M. and visited a large area of coppice with standards in the Thudaumot district. The forest is managed to supply the Saigon market, and it was a surprise to me to see coppice with standards working so successfully in evergreen forest.

The coppice rotation is 20 years, to be raised to 30 years, with a view to bringing in a conversion to high forest, after 4 coppice rotations. The yield is 1,680 c.ft. stacked of firewood per acre, fetching about 1·3 annas per cubic foot in the stem. What surprised me most, was to learn that there is no difficulty in getting a fine crop of coppice shoots, and that in addition there is always an ample crop of seedlings to make up for any loss in old stumps. The density of the underwood in some of the older coupes struck me as excellent. I had not time to go into the question of how far the valuable timber species came on in these forests, but as these forests were almost completely cleared of durable timbers before they were taken over by the Forest Service some 17 years ago, it was too much to expect them to carry a good stock.

The European staff in this area struck me as being large, compared with what we are accustomed to in India, more particularly as the area is served by two first class metalled roads and a very good supply of *kutcha* tracks, which motor cars can get over.

On the second day we had to start at 4 A.M. to cover the 80 miles to the forests in the Bien Hoa district. It is an hour at which I particularly dislike starting, although unavoidable in a climate like Saigon, but I felt a certain amount of malicious joy, in thinking that we were getting some of our own back in waking up the town, for that first night in the place. Wonderful to relate all the cartmen on the roads at that early hour were awake, and on their proper side. What a contrast to the U. P. where they aren't awake at noon, and never keep their proper side!

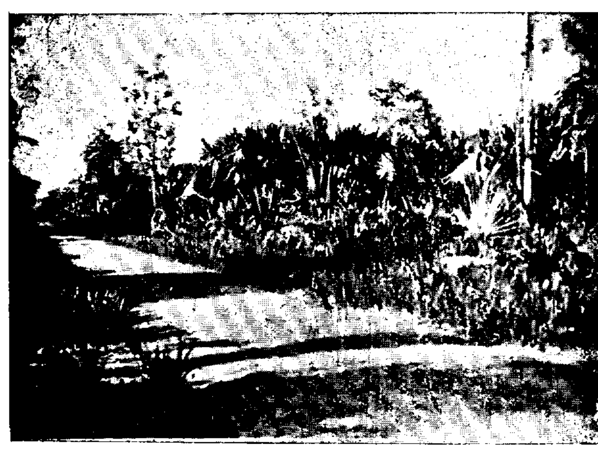
8. *Dipterocarpus* forest.
Bien Hoa Province.



9. *Lagerstrœmia calyculata*.
Bien Hoa Province.

Photo-Mech. Dept., Thomason College, Roorkee.

10. "*Ray*" land growing up.



Photos by W. A. Robertson, I.F.S.

11. Palm forest on the border of Annam.

Dawn found us in rolling country with a deep red soil lying on limestone, very similar to the red soil of the Shan plateau. Most of the forest had been cleared for cocoanut and rubber plantations, which looked very thriving and were excellently kept up. Further on towards the border of Annam we get off the red soil, and got into magnificent *Dipterocarpus* forest, the size of the trees rivalling those of the Andamans (photo 8). The two most valued species *sao* (*Anisoptera* sp.) and *Hopea* had been cut out, so I was told, but the remaining stock was still very fine. There were a certain number of blanks, with a thin stock of a tree resembling *Dipterocarpus tuberculatus*, but not exactly, and a dense ground cover of Burmese *thetke* grass, which M. Meslier told me had proved impossible to deal with, on account of fire. I could not account for these sudden transitions from dense evergreen to very dry types. At first, I thought they might be *ray* areas, *i.e.*, old patches of shifting cultivation cut by the Moi who seem to be an offshoot of the Karen, but M. Meslier assured me that the *ray* lands eventually restocked themselves. This was borne out by what we saw further on. The *ray* lands become covered with a fairly dense growth of *Randia* and other thorny species which I could not identify, and under them the evergreen works back again (photo 10).

Further on still, just on the Annam border, a completely new type of forest started. The height of the trees diminished, and a palm which looks like a stemless *Corypha* formed the principal species (photo 11). I understand that it extends for miles along the road, which is the main road from Cochin China to Haiphong. Owing to the value of the palm for its minor products, this type of forest is at present almost as valuable as the timber forest, for the uses of the palm are nearly as numerous as those of bamboo. It appears that one can house, clothe and generally fit oneself out, almost entirely from it.

For the moment, these timber forests are hardly being worked owing to the expense of transport. On our return, we passed a forest which is being set aside for sample plots. M. Meslier tells me, that up to this year it has not been possible to do any intensive work on them, owing to want of funds, but that this year he has

been able to put a whole time officer in charge. The data from these plots when they become available, should be very useful to India, where so little is known as to the growth of the evergreen species.

Now, the rest of the acts in Saigon, and all that we did, are not written in any chronicle, nor were they worth it, so we left with confirmed dislike of the climate, and a hearty appreciation of the kindness of the "Service forestier de Cochinchine."

In conclusion, it may be mentioned, that Saigon is one of the most expensive places in the East, and doing things in a very quiet way, the cost of the trip to Angkor, and the necessary stay in Saigon, runs into the best part of £50, but so far as Angkor is concerned, it is well worth it.

W. A. ROBERTSON, I.F.S.

THE INTERACTION BETWEEN PINUS LONGIFOLIA *ROXB.* (*CHIR*) AND ITS HABITAT IN THE KUMAON HILLS.

I. THE CHARACTERISTIC OF THE SPECIES.

General.—The *chir* pine has in a pronounced degree those morphological and biological characteristics which may be considered typical of the three needled pines as exemplified by the New World *Pinus palustris* Mill and *P. ponderosa* Dougl., combined with something of those of the two needled species such as *P. sylvestris* L. and *P. maritima* Poir.* A detailed account of these peculiarities would be superfluous, but a cursory examination of at least those which have the most intimate bearing on the subject in hand, is essential to an adequate understanding of the latter. The same is the case with its peculiarities as a conifer and as a *Pinus*, though these also are of great importance in con-

* According to MAYR'S [1] classification of the genus, *P Longifolia* differs from all these species in having simple walls to the tracheidal cells of the medullary rays: in this it agrees with the pinons of America and *P. Gerardiana* Wall., but it is given a special section, *Sula* on account of its different simple medullary ray pits which agree with those of the section *Jeffreya* including *P. palustris* and *P. ponderosa.* Such anatomical data are useful as confirmatory evidence for a classification on more general characters, but give very artificial results if used independently.

nection with its relations with the broad leaved trees with which it comes into contact or competition.

Morphological Features.—Firstly the tree shews a whole series of characters usually considered xerophytic, which appear to be adaptations to the climate and habitat which it affects, a habitat subject to more intense heat, drought and insolation than that of the majority of its allies, but at the same time including a fairly typical cold season with liability to frost and moderate snow fall. The needle habit, the long taproot, the heavily sclerosed cone, and the well developed winter bud are characteristic of all pines, and it is a moot question how far these features are special adaptations to a present xerophytic habitat (WARMING[2]), how far they are an inheritance from the times when the genus was first differentiated as such (STOPES[3]), or how far they have been carried with more recent migrations (SCHIMPER OF STOPES[3]). All the features enumerated are important, and the large winter bud is specially noteworthy being paralleled among associated plants in the *Lauraceæ* and *Rhododendron.* As special xerophytic features may be noted the fleshy cortex of the small seedling, the very thick bark on large trees, and the exceptionally large and woody cone.* The feature which gives rise to the specific name. *i.e.*, the long soft needles, cannot however be regarded as adapted to specially xerophytic conditions; it may even be the reverse and is perhaps rather a device for increasing assimilative activity during the moist season, when checks on transpiration are a handicap. SCHIMPER[4] does not accept conifers as true xerophytes apart from rare exceptions.

These characters now appear very like adaptations towards effective resistance to fire injury (TROUP[5] p. 67), though they are unlikely to have originated as such, this is however not out of the realms of the possible, being more probably true xerophytic adaptations† in the first place. Other such features are the non-

* The Californian *P. Sabiniana* and *P. Coulteri* affect very similar habitats to that of *P. longifolia* and produce cones of record size and weight.

† Many pines, especially in North America, such as *P. resionosa* and *P. tæda* have richly resinous bark as also have *Pseudotsuga* and other genera.

resinous nature of the bark, and the existence in large numbers of dormant buds in young plants especially in the fleshy hypocotyledonary region of the small seedling—ready to develop in any emergency.

The rich resin content of the wood is a very important point in all that affects *chir*. Whilst probably responsible for the relative immunity of the tree to insect and fungus damage, it is likewise answerable in fire swept tracts for the fall of many a tree burnt through at the base where some injury or other has broken the bark surface (OSMASTON[6]).

The seed with its tough and sclerosed coat, winged and capable of being carried by the wind some 100 yards or more from the parent tree must be noted, as also its edibility both to man and various birds and animals.

The wood, of typical 2-needled pine histology and anatomy, is brittle when cold, and this feature combined with the growth form of the tree results in a considerable degree of liability to snow break. It is also no rare thing for trees to be uprooted and overthrown by the weight of the snow accumulated on the crown, although the tree is tolerably well adapted to resist such injury.

Biological Features.—Biological characteristics which are of special importance to the tree have also to be touched upon.

The seedling in its first season, except under the most favourable conditions, is relatively feeble and weak, only reaching 3" in height and being unable to withstand the lightest fire or trampling, etc. The main reason for this may perhaps be the way in which the delicate hypocotyledonary region stand most exposed, and injury to this part easily occurs and is usually fatal. In the second season, the spongy cortical tissue already mentioned develops considerably, as if aware of the need of special protection. Dormant buds in a whorl just above the cotyledons and others in the axils of all the lower juvenile leaves (which normally never develop the needle bearing spur shoots and so lose their growth powers) are ready to develop if any injury comes to the leading shoot and in fact some of them commonly grow out as

lateral branches in any case, especially under poor soil conditions-under good conditions, they often grow an inch or two and then die off again, all growth energy being concentrated in the leading shoot. These buds are mostly buried deep in the spongy 'carrot' which has itself settled more deeply into the soil, and the plant will be able to coppice if the leader is burnt or otherwise incapacitated. Replacement of the leading shoot by a lateral branch may be repeated several times, but the root system goes on developing, and the growth of the coppice shoot as of the uninjured young plant, soon becomes sufficiently rapid for at least the growing point—buried in green foliage as they are—to withstand an ordinary surface fire, and the seedlings very quickly shoot up beyond danger of competition with grass and shrubs.

The young plant can stand a very considerable amount of shade, and will for instance grow quite well under the immediate shade of the parent trees, at least till it is several feet in height without shewing appreciable signs of suppression. Thereafter direct overhead light is necessary for full development, but shade tolerance is still sufficient to allow of dense thickets spring up in which the competition for light and space may be so severe that despite the disappearance of the majority of stems, the individuals persisting are numerous enough to make crown and girth development extremely slow. Thus, during its growth, the tree has become a pronounced light demander, and for optimum development whether as an individual or a crop, abundant crown space is required, and ultimately, as it passes maturity, a typical umbrella-shaped crown with a clean cylindrical bole is developed.

The new foliage is expanded at the beginning of the hot weather, as soon as the night cease to be cold, and the days are warm enough to ensure active assimilation beyond the capacity of the worn out old foliage. The old crop of needles soon falls off in exposed places, and in some trees so quickly that for a short time the trees appear almost as if they were deciduous.*

* The occurrence of scattered trees in which this phenomenon is specially conspicuous is often to be noticed: they even give the impression of being a different species from their normal neighbours. (cf. TROUP[5], p. 24.)

In young trees, the old foliage may be retained for another whole year or more, but it is often striking how much of it grows brown during the cold weather, presumably from the effect of frost. The heavy fall of needles in April-May forms a thick dry mat over the soil, protecting the latter from loss of moisture, hindering the development of small vegetation whether herbaceous or woody, and preventing the seed from reaching the mineral soil. Under average conditions the mat of needles is very slow to decompose, and so may accumulate to a considerable thickness.

Chir puts in its active growth before the rains (with an occasional second spurt towards their close) and this may indicate a check in growth activity by the more or less saturated atmosphere during the rains, though turgity is generally favourable and even necessary to growth.

The pollen is shed and pollination occurs just before the leaf buds open up, and the cones mature and shed their seeds some 27 months later, *i.e.*, in the hot weather of the second season. Seed production is poor except in regular seed years, which though very irregular in occurrence, recur on average about every four years. Failure to produce seed appears to be chiefly ascribable to a failure to produce carpellary cones two seasons earlier, rather than to subsequent mishaps, and as usual, the coincidence of a good seed crop with favourable germination and establishment conditions, will be a matter of pure chance. The critical period for the seedling is the long dry period between the first and second growing seasons, from October to the following June. In that the seed falls during the hot weather and germination takes place with the first good shower of the rains, the best possible chance is given to the young plants, but failure of the winter rains, or an extra long and dry hot weather results in a very heavy mortality among them. In any case there will be large percentage of casualties, owing to the edibility of the seed and small seedlings to birds, rodents, and insects.

Advantages and disadvantages.—For the object here in view, it is helpful, to summarise these characteristics both morphological and biological, according as to whether they may be considered as a help or a hinderance to the species in its struggle

with its neighbours, and the physical features of its habitat. As advantages may be considered :—

(i) Unusually highly developed coppicing power facilitating resistance to all forms of injury in youth.

(ii) Heavy seed production adapted for wide dispersal, endowing the species with pronounced colonising powers.

(iii) Shade bearing powers of young plants allowing the establishment of regeneration.

(iv) Rapid height, in youth, enabling the sapling to get above its competitors, and so to oust them.

(v) Heavy needle-fall, preventive of regeneration of other species.

(vi) Fire-resisting power of the mature tree enabling it to retain territory once gained.

As against these favourable attributes, there are certain drawbacks such as :—

(i) Weakness of the seedlings in their first season resulting in heavy seedling mortality.

(ii) Inflammability of the forest : exposing the regeneration to destruction by fire.

(iii) Inflammability of its secretion product, resin, increasing damage by fire.

(iv) Inability to survive heavy lopping, leading to death of poles exposed to this form of injury.

(v) Pre-eminent suitability of the poles and timber to villagers' requirements, occasioning selective fellings of the species.

(vi) Irregularity of seed production resulting in the loss of opportunities of regeneration.

(vii) Edibility of the seeds and young seedlings, acting as a considerable handicap to regeneration.

II THE HABITAT.

(*a*) *Geographical Range.*—The geographical range of the species is described in detail by TROUP[5] (p. 1—20) who records it as extending all along the outer ranges of the Hima-

laya and the Siwalik hills, from Bhutan in the east to Afghanistan in the west. Over the major part of its range, *chir* is found in quite, or at least relatively pure crops, to all appearances free from any serious competition with other species. Whilst most, if not all such forests have been more or less altered by human agency, whether directly or perhaps only by means of fire, from their original virgin condition where the only struggles are those against the physical environment and between individuals, it appears in general grounds unlikely that the *chir* has only come in as a later immigrant into a pre-existing vegetation. The same areas have probably been under *chir* for a very long period.

Atmospheric moisture and rainfall.—Detailed information is not available as to the rainfall in the different parts of the range, but it probably varies from 40″ to 100″. (TROUP[5],) p. 13). The outer ranges get a much higher fall than the inner during the monsoon, but the latter often get the benefit of more showers during the rest of the year from the storms originating locally or coming from the N.-W. which often do not reach the outer hills. This results in the anomaly that some of these outermost South facing slopes have the maximum total precipitation but are the most xerophytic, the effect of short rainfall during the cold and hot weather combined with intense insolation and resultant high temperature outweighing that of the heavy monsoon downpour, most of which is very rapidly drained off.

(*b*) *Physical requirements.*—In the central part of its geographical range, and in so far as man has not interfered, *chir* may be expected to occur in such pure crops on all ground possessing the following characteristics :—

(i) *Altitude* of 3,500′—6,000′ on S. aspects, falling to 5,500′ on N. aspects.

(ii) *Rock,* any occurring in its range.

(iii) *Soil,* any, excluding very shallow rocky soils subject to intense insolation, and stiff clays.

(iv) *Moisture,* almost any degree provided the subsoil is well aerated.

(v) *Insolation,* not less than average.

Surrounding and to a less extent interpenetrating this region of undisputed predominance, are found forests in which the *chir* is more intimately associated with other tree species some at least of which are capable of competing with it for the dominant place in the leafy canopy, and as one passes outwards from the optimum for *chir*, the pine first loses its unrivalled sway, then its ability to keep level with its competitions becoming restricted to smaller or larger groups, where chance or particularly suitable conditions have come to its aid, and finally its ability to to persist at all.

Considering first the limiting areas of the altitude zone to which *chir* is restricted, it comes into contact at the lower limit with *Shorea robusta*, and a large variety of broad-leaved trees typical of the low hills and often extending far out into the plains —the more or less xerophytic deciduous monsoon forest of SCHIMPER. In this connection, the restriction of the genus *Pinus*, especially of the big tree species, to temperate climates may be noted, so that on general grounds, one would not expect to find pines associated with such a tropical association. The exact reasons for this cannot be given ; the considerable degree of xerophytic adaptation argues against the suggestion that it is the heat and drought of the hot weather at lower elevations, which is the limiting factor (cf. TROUP[5], p. 17) though any inadequacy of the conducting tissues (STOPES[3]) to meet even the requirements of a reduced transpiration, would produce this resuit.*

It seems more likely in the case of *P. longifolia* that it is due to the combined heat and wetness of the monsoon period working

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* Some interesting data are available in this connection for a comparison between conifers and their broad-leaved associates. EWART[7] in his study of the ascent of water in tree contrasts the tracheids of *Taxus* only 25 mm. long with the tracheæ of the pear tree, etc., which are about 20 cms. long. The rate of flow of water through such elements under a given head varies as the square of the radius so that the diameter difference between, 025 mm. for *P. sylvestris* and 1 mm for *Quercus* means that the flow is over 1,000 times greater in the case of the latter. STRASBURGER showed that *Taxus* wood requires a head of several times the length of the section used to drive water through at the transpiration rate, whilst a column of the same length as the section sufficed for *Acacia* sp.

VON HÖHNEL at Mariabrunn found that *Pinus laricio* transpired 3·2 grams for 100 grams dry weight of leaf as compared with 30·60 grams for broad-leaved species.

through some such channel as reduction of transpiration below what required at a time of considerable assimilative activity, but it may possibly be something quite different, such as the lack of and adequate cold resting period, or the inability of the seedling to establish itself among the herbaceous and woody seedling competition prevalent under such conditions. The mixed type does indeed often look as though the *chir* found difficulty in establishing itself, though flourishing well enough once established—experience with artificial sowings in Dehra Dun and elsewhere is similar.

At the upper limit for *chir*, the oaks, *Rhododendron Pieris*, etc., which accompany it through most of its zone of optimum growth if only in small proportions, become more and more intermixed with it, until they finally replace it entirely. In addition to the expected slower growth, less height at maturity, and reduced general vigour to be expected under the more rigorous climatic conditions, the beginnings of an epiphytic growth of mosses, lichens and ferns indicative of considerable atmospheric moisture become noticeable, and again suggest that this moisture is intimately connected with the disappearance of the *chir* through whatever channel it may work. As alternative explanations, there is the possibility of an inadequate growing period, or excessive cold for the proper development of the seed. *Quercus incana* which is the chief competitor at these altitudes is well fitted for the struggle for territory, especially in its ability to withstand lopping and coppicing almost indefinitely and in casting a shade too dense to allow of *chir* regeneration below it.

Of the remaining limiting factors mentioned, moisture and insolation may be taken together. It is very generally found that any shady hollow or ravine traversing the optimum altitude zone of *chir* carries more or less broad-leaved tree growth which succeeds in excluding the *chir* to a varying degree. The species concerned are for the most part those of the higher altitudes, especially *Q. incana* and *Rhododendron*, and the reasons are at least in part the same. It may frequently be seen that such *chir* as does occur in these places is exceptionally good : *chir* can grow and grow well, and the reason it is unable to maintain its predominance must lie in the difficulty in getting established and

making a start. Soil and moisture conditions in these hollows are obviously more favourable than on the more exposed slopes adjoining them, and this enables the broad-leaved species to grow densely enough to prevent the establishment of the *chir* seedling (cf. TROUP 5, p. 17). It will be seen that if the oak growth is held back, *chir* occupies these spots also. Along the ravines whereever water is at all excessive and soil aeration is in consequence rather poor, *chir* will not grow, and *Alnus* may be expected; there can be no question but that *chir* requires good soil aeration

As already implied, breaks in the undisputed dominance of the *chir* may also occur where the soil is stiff. A considerable admixture of *Cratœgus*, *Pyrus*, etc., is found in such places and what *chir* occurs will be of poor growth. This is clearly also a case of poor soil aeration.

(*c*) *Associates*.—In the preceding paragraphs it has been attempted to trace the physical causes limiting the distribution of the *chir*. and some mention has been made of various trees associated and sometimes competing with it; a rather more detailed examination of this association is needed.

At the lower limit.—At the lower elevations, extending up from the *Bhabar* and *Tarai* tracts, *Shorea robusta* meets the *chir* and overlaps it to a certain extent. Generally the elevation is high for *sal* and its growth is not very good—in fact an inferior understory to an open stand of *chir*, or a low open crop of *sal* with *chir* standards are the usual types. Locally, however, the balance may be more equal, the *chir* tending to occur in groups or strips particularly along the crests of ridges—among a fair *sal* crop; this is especially the case where the forests have been protected for a considerable period. In these places the associated species are rather different from those one finds with the *sal* on the plains, such species as *Hymenodictyon*, *Kydia*, *Engelhardtia*, *Anogeissus latifolia* and *Terminalia Chebula* being most general with much *Buchanania latifolia* in dry places, but none of these are of special importance in connection with the *chir*. In the damper spots in this mixed type, the *chir* is still further excluded in favour of such trees as *Eugenia Jambolana*.

The undergrowth varies a good deal, being conspicuously affected by the amount of moisture: in dry places *Aechmanthera tomentosa* often occurs gregariously and completely covers the ground whilst a tangle of "*bhabar* grass" is characteristic of the outermost ranges: where moister, there is more variety, other Acanthaceous shrubs being conspicuous among many other species.

On rocky slopes exposed to the south, sal is generally absent, and *chir* comes into contact with the more definitely deciduous miscellaneous formation in which *Erythrina suberosa*, *Sterculia pallens*, *Odina Wodier*, *Kydia*, *Wendlandia exserta* *Nyctanthes*, *Ougeinia* and several *Bauhinia's* are the commonest forms. These trees, each with its own peculiar requirements and characteristics, mostly occur singly or in small groups and direct competition with the *chir* is not very severe. They mostly leaf out at the com mencement of the rains, and their shade with that of the lianes typified by *Bauhinia Vahlii*, doubtless hinders the germination and establishment of the *chir* seedlings, but the struggle for the pine appears in the first place to be more against the physical features of the environment, than against competing neighbours.

The undergrowth is very largely shrubby, including the same species as for the sal but with others more conspicuous such as *Woodfordia* and *Rhus parvifolia*; there is also a considerable harbaceous growth in the rains. These plants do not appear to hinder the *chir*, at least in the long run, and perhaps even aid it.

There are practically no really common tree species reaching their maximum development in the main *chir* zone *Glochidion velutinum* *Engelhardtia* and *Ficus Roxburghii* may however be considered typical of it; they occur as scattered single trees in the understory, and hardly affect the dominant species. Most of the broad-leaved trees to be found here are obvious stragglers from the mixed forests above and below—thus *Eugenia Jambolana*, *Wendlandia exserta*, and *Terminalia Chebula* and *Ougeinia*, all struggle up from below, whilst *Q. incana*, *Rhododendron* and *Pieris* similarly stray downwards, or outwards from the ravines where conditions allow. The same is true of the undergrowth, but some species such as *Indigoferă Dosua*, *Inula Cappa*, *Plectranthus ternifolius*, *Desmodium gyrans* and the spear-grass *Andropogon contortus* are

particularly noticeable. OSMASTON[8] (p. 18), gives an interesting list of the chief under-shrubs classified according to the aspect on which they are most abundant. From clearings and cultivated areas *Cratægus*, *Rosa*, *Ficus palmata*, *Rubus ellipticus*, *Berberis asiatica* and the like spread out into the *chir*. The absence of spring herbaceous vegetation as contrasted with its pronounced development in adjoining broad-leaved deciduous forest, is mentioned as characteristic of coniferous forest by SCHIMPER[4].

The association already referred as typical of the hollows and ravines in the main zone, possesses importance as a centre from which a variety of species can spread rapidly among the *chir* as soon as the temporary equilibrium is upset through any agency. As already noted, the species found are in the main typical of higher altitudes, but some, such as *Quercus glauca*, and *Debregeasia hypoleuca* find their optimum conditions here. *Machilus odoratissima*, *Acer oblongum* and *Olea glandulefera* with a wide altitudinal range also do very well. Among species with their optimum lower down, *Eugenia Jambolana* may be mentioned and various lianes (*Vitis lonceolaria*, etc.) and epiphytes (*Rhaphidophora glauca*) are characteristic.

From the mode of occurrence of all these species, scattered more or less singly in the *chir* zone, and never in real mixed stands with it over appreciable areas, it follows that the inter-relationships are not of great importance to the forester : the fact is, that they have all been definitely relegated to a secondary place in nature, whilst *chir* occupies the optimum stations. So it may be concluded that these species persist, thanks to their adaptation to the special conditions of this secondary habitat, and are only able to compete with more or less success with the *chir*, when this is in the seedling stage thanks mainly to their shade throwing and shade enduring powers.

At the upper limit.—The only species of importance at the upper limit of the *chir* as already mentioned are *Quercus incana*, *Rhododendron* and *Pieris*, and the last two are ephemerals of small lasting influence. From their different growth habits, one would expect what one actually finds, *viz.*, these broad-leaved species appear as an undergrowth, and then as one ascends, the

overcrop thins out to final disappearance. *Quercus lanuginosa* may also be found growing as a sort of understory to *chir*; its biological behaviour is very similar to that of the *banj* from which it differs in being rather more adapted to xerophytic conditions and the association is strongly reminiscent of *Pinus maritima* and the cork oaks in S. France.

(d) Extraneous Influences—General.—Influences not actually physically connected with a given locality, but reacting on the vegetation there, must be considered as among the factors which go to build up what is comprised in the term "habitat".

(i) Natural Influences.—It has been seen above that the amount of moisture in the atmosphere, especially during the active vegetating season, is apparently of first importance in deciding the distribution of *chir*; apart from this, atmospheric influences do not affect *chir* very greatly. Snow-break and wind-fall both occur but on no important scale. Lightning frequently strikes trees and is usually fatal, the effect sometimes extending beyond the tree actually struck, adjoining trees dying off in an ever widening circle for 4 to 5 years more, but this again is a relatively small matter. Lightning also occasionally originates fires and may accordingly have been a more important factor than is suspected in the evolution of those attributes of *chir* which now enable it so stoutly to withstand fires originated by man.

For a pine, *Pinus longifolia* is unusually exempt from serious damage by fungi or insects. Although a number of notoriously destructive genera, such as *Ips*, are abundant in these forests, with species even exclusively attached to the *chir*, but very few cases have been recorded of primary and fatal attack, BEESON[9]. Only under the artificial conditions of plantations is there any indication that such agencies may become of importance in affecting the spead of *chir*, *e.g.*, *Peridermium*: cf Champion ([10].) With this immunity may be compared the wholesale destruction in the N. American pine forests by the beetles of the genus *Dendroctonus*, the damage done by *Hylobius* and *Myelophilus* in Europe, and the havoc wrought by *Peridermium* on *Pinus Strobus*. Since these destructive agencies have not, to all appearances made themselves obtrusive under conditions ideal for them,

as after the exceptional fires of 1916 when tens of square miles, of forest were full of fatally injured or weakened trees, it seems safe to assume that apart from the risk of imported dangers, *chir* is singularly immune in this direction.

(*ii*) *Man's Influence.*—A very active factor of the habitat occupied by *chir*, is the advent and settlement of men with their flocks and herds of domestic animals. The results of this invasion have been discussed in another note (CHAMPION [11]) where the ways are enumerated in which the forest is affected *i.e.*, the added conditions to which the species must adapt, itself or go under. These are burning, felling, lopping, browsing removal of litter and trampling of the soil and are discussed later.

(*iii*) *Afforestation.*—With the realisation of the destruction in progress, has come the realisation of the necessity for placing some check on it, and for the replacement of some of the destroyed forest cover, and hence the plantation work which has been and is being done. The destruction having been mainly in the pure *chir* zone, afforestation with *chir* has naturally followed, so that at present whilst the destruction is in no wise stopped, some effort is being made to make amends—an economically unsound method but one which has its effect on the distribution of *chir* and one which must however gradually inculcate the lesson that destruction is easier than reconstruction, and so ultimately check the former process. It has been emphasised that the plantations have to be established on soils of greatly reduced quality class, and under exceptional exposure to insect and fungus attack.

H. G. CHAMPION, I.F.S.

[*To be continued.*]

ŒCOLOGY OF INDIAN SAVANNAH PLANTS.

While at Gola Tappar, Dehra Dun Forest Division, and in the Bengal Duars, the writer had the rare opportunity of studying several typical cases of natural conversion of a grassland into woodland, and it may be of interest to record a few observations in connection with the œcology of important transitional trees which are among the first to encroach into and ultimately displace grass.

For this purpose it is not necessary to discuss the exact origin of savannahs. It may be some of them were grasslands *ab initio*, while as regards others there are authentic records (*e.g.*, the Gola Tappar, for instance), or reliable indications (*e.g.*, some parts of the Bengal Duars), that they were once a part and parcel of the adjoining forests. In the pre-protection days, however, they were cleared for cultivation by itinerant cultivators, who are always after "fresh fields and pastures new," but subsequently abandoned.

The process of conversion, or more properly reconversion, and the various phases through which it passes, are now well-known. That there is a constant and keen struggle between

Photo-Mech. Dept., Thomason College, Roorkee

Photo by Sher Singh, P.F.S.

The Gola Tappar, (Rikhikesh).

Note the Savannah grasses which are well above a man's head.

The grasses are chiefly *Sachharum Narenga*, *S. Munja* and *Anthisterea gigantea*.

In the background, there is a wall of adjoining Sal forest, of which the Tappar was once a part.

The big leaved tree with oriented leaflets towards right is *dhak* (*Butea frondosa*) and that towards left *Cassia Fistula*.

The long pods of *ameltas* can be seen hanging in the middle.

these two types of vegetation, has been well expressed by Schimper, the great plant geographer, in his Geography, where he says, "woodland and grassland stand opposed to one another, like two equally powerful, but hostile nations, which in the course of time have repeatedly fought against one another for the dominion over soil." From the point of view of œcology, as also the practical consideration of afforesting *tappars* (savannahs) it is of great importance to discover the factors that equip the so-called "pioneer" species for their part in this struggle, and which ultimately lead to their triumph. The "pioneer" species belong to different families, and possess widely different shapes and forms, but in the course of study, it was found that there are several features which are common to all of these species and it is the object of this communication to record them as briefly as possible.

The species which are most frequently met with in savannahs in North India are :—

A.
1. *Dillenia pentagyna*
2. *Careya arborea*
3. *Bombax malabaricum*
4. *Butea frondosa*
5. *Callicarpa arborea*
6. *Eugenia operculata*

and less frequently

7. *Macaranga denticulata*
8. *Clerodendron infortunatum*
9. *Miliusa velutina*
10. *Bischofia javanca* (in wet savannahs only)
11. *Albizzia procera* (,, ,, generally)
12. *Stereospermum suaveolens*
13. *Mallotus alba* (also *Mallotus philippinensis*)
14. *Holarrhena antidysenterica.*
15. S*emecarpus anacardium*
16. *Oroxylum indicum*
17. *Ficus hispida*
18. *Cassia Fistula*

and a few others to be mentioned later.

Of these, species included in group A are most frequent, but the remaining species also occur in savannahs either sporadically or in small patches and it is as well to include them in this list, in order to find whether the same characters are common to them.

Some of these species possess a very charming appearance, which if once seen can be hardly forgotten. Thus, *Butea frondosa* in the month of February presents a superb sight when it bursts forth into a blaze of scarlet blossoms, for which reason it has been aptly called "the flame of the forest," particularly when it has cast off its leaves and donned a garb of gorgeous red blossoms. *Macaranga denticulata*, finding suitable conditions, form dense thick walls of its peculiar peltate leaves, a feature so characteristic of the protected Duar savannahs. *Cassia Fistula* is one of the most beautiful Indian flowering trees.

The actual distribution of these species depends on many local factors, climatic as well as edaphic. Thus *D. pentagyna* is very common in Bengal and Assam savannahs, whereas in *tappars* near Dehra Dun, it is altogether absent, the reason being that it is sensitive to frost which is absent in the Duars, whereas it is a serious danger in the Dun. Again, *Macaranga denticulata* generally comes in after the establishment of fire protection, whereas *C. arborea* and *Dillenia pentagyna* are able to exist in savannahs which are burned annually.

Before passing on to a consideration of the features common to these plants, it is necessary to refer briefly to the chief obstacles in the way of establishment of these species, or for that matter any foreign species in a grassland.

Obstacles to be encountered in a grassland.—The obstacles are—

(*a*) Keen competition for light,

(*b*) Exposure to climatic dangers, namely, frost and drought,

and lastly (*c*) Liability to repeated annual burning (at any rate in unprotected savannahs).

These factors work in conjunction, but in fire-protected savannahs, the last danger may be altogether eliminated or con-

siderably minimised, in which case, the factors that come prominently into play are the first two only, namely, suppression by grass, and the ordeal of exposure to frost and drought. From another point of view also, first two factors are more important, because they govern primarily the first entry of a foreign species into grassland, whereas the last factor operates only negatively, *i.e.*, eliminating such species as are unable to withstand the damage done by firing.

Of these two factors (a) and (b), the first factor, namely, competition for light, is the most important, because light is at once a source of energy and of food supply, to a plant, and without it the plant activity would come to a standstill in the same way as a steam engine would stop without a supply of water. Given necessary capacity for absorbing the maximum possible amount of light, in this arduous competition with grass, a plant may be able to struggle, at any rate for some time, against adverse conditions of frost and drought, but without the capacity to absorb light, the very existence and establishment of the plant are foredoomed.

In addition to the above considerations there also come into play a few other factors, *e.g.*, facility for seed dispersal. Othe things being equal, the greater the facilities for seed dispersal, the wider the distribution and the greater the chances of success of a species. Thus small sized seeds and especially those provided with hair (*e.g.*, *semul*, *Bombax malabaricum*), or wings, have better chances for success in this uphill task of colonisation than plants possessing heavy seeds. On the other hand, the size of seeds is not the only factor governing the distribution of a species into savannahs. Thus weight for weight, the seeds of *haldu* (*Adina cordifolia*) are about 300 times as lighter than the seeds of *Dillenia pentagyna*, but *haldu* is not abundant, in fact very rare, in the savannahs.

A —LIGHT ADAPTATIONS.

(*i*) *Law of leaf expanse.*—As we have seen above, the capacity to absorb the maximum amount of light is one of the most useful, if not the most valuable of the weapons in the armament of an invading species. The significance of this would be self-evident to those who have seen these savannahs in their natural condition of

growth. The gregarious grasses grow in such congested clumps that every corner of ground is covered, and little or no light is allowed to filter down to the mineral soil, beneath where the intruding species must obtain a foothold and begin its career, before it can rear its head above grass.

Plant physiology teaches that leaves are the laboratories where plant food is manufactured by absorption of carbonic acid gas, through stomata, in presence of sun light. The bigger the leaves, the greater the number of stomata generally, and the more rapid the manufacture of the food, and consequently the growth of the plant.

Coming now to the "pioneer" species mentioned above, the most striking feature which arrests the attention of any observer, is the extraordinary expansion of their leaves. Thus a leaf of *Dillenia pentagyna* measured at Nilpara, Buxa Division, Bengal, was found to be 59" × 18", *i.e.*, about five feet, by one and a half feet. Leaving aside the palms and the bananas, which belong to the the Monocotyledons, this leaf is, perhaps, the largest among the Dicotyledons. Although this size is not reached by any other species except *Oroxylum indicum*, other species common in the savannahs also possess remarkably big leaves. The following table has been drawn up to bring out this fact more clearly:—

S. No.	Name of savannah plant.	Length of leaf of rachis in case of a compound leaf).	Width of leaf lamina (in compound leaves the lamina is supposed to be continuous).
1	*Dillenia pentagyna*	59"	18"
2	*Oroxylum indicum*	48—72"	36"
3	*Stereospermum suaveolens*	24½"	6"
4	*Bombax malabaricum*	21"	20"
5	*Butea frondosa*	24½" (length of petiole 14½").	
6	*Semecarpus anacardium*	24"	8"
7	*Careya arborea*	18"	6½"

S. No.	Name of savannah plant.	Length of leaf (of rachis in case of a compound leaf).	Width of leaf lamina (in compound leaves the lamina is supposed to be continuous).
8	*Macaranga denticulata*	24″ (length of petiole 10″)	12″
9	*Ficus hispida*	$16\frac{1}{2}$″ (petiole 4″).	7″
10	*Cassia Fistula*	24″	12″
11	*Macaranga denticulata*	24″ (petiole 10″).	12″
12	*Holarrhena antidysenterica*	14″	5·5″
13	*Mallotus alba*	27″ (petiole 14″).	12″
14	*Clerodendron infortunatum*	17″ (petiole 6″).	8′
15	*Miliusa velutina*	10″ (petiole 1″).	6″
16	*Albizzia procera*	15″	12″
17	*Bischofia javanica*	12″ (petiole 6″).	6″
18	*Eugenia operculata*	6″	4″

Measured at Nilpara, Buxa Division, Bengal.

N. B.—Leaves selected are not average. On the other hand,

(1) these dimensions are by no means absolute maxima.

(2) The reason why compound leaves have been considered as if they form one continuous lamina, is given in B (iii).

From the point of view of grasses, these species are most dangerous enemies, because the bigger their leaf surface, the greater the shade cast by them, and therefore the greater the ease with which they displace the light loving grass. This fact has an important bearing in practical forestry and it is therefore that in afforesting *tappars*, such plants are selected as are not only large leaved, but which are more or less evergreen in order that leaf cover once formed, may not be interrupted to let grass re-enter. Thus in the Bengal Duars, although *semul*, and *kainjal* (*Bischofia javanica*) are both used for afforesting *tappars*, the latter is much preferred and gives greater success because, unlike *semul*, it is never without leaves.

It will be seen that the above list comprises nearly all the large-leaved dicotyledenous plants of India, excepting a few species to be mentioned hereafter. The expansion of leaf laminæ is, therefore, the most obtrusive, and, as we have seen, the most significant factor in their œcology. In fact, it is so characteristic of savannah plants, that it may be laid down, as a general law, that only such species as possess big leaves, can succeed in struggle with grasses, and are, therefore, naturally found associated with them.

As to what constitutes a "big leaf," it is not necessary to define. In the very circumstances of the case, the estimate of dimensions must be more or less comparative, but few will dispute the fact that above plants are big-leaved. A doubt may be expressed as regards the size of *Eugenia operculata*, it may be small in comparison with *C. arborea* leaf, for instance, but it is fairly big for the purpose required, and is much bigger than the more familiar member of its family, namely, *Eugenia Jambolana*.

The two other large-leaved trees which would naturally suggest themselves in this connection are evidently teak and sal, our most important forest trees. The leaves of teak may be as big as 24" × 12", and those of sal 12" × 7". And even as regards these trees, there is sufficient data to warrant the conclusion that *they are themselves savannah trees*. With regard to sal, there is absolutely no doubt, that this is the case, and many examples are met with in the Bengal Duars, where one can actually see, the savannah grasses being directly encroached on, and replaced by sal. It also possesses other savannah characters, *e.g.*, *anthocyan* colouring, etc., to be described presently. The same is probably true of the sporadic teak in Southern India and Burma, where the big expanse of its leaves, more than anything else, helps it to compete with grass or its relatives, the bamboos.

On the other hand, it is not intended to be conveyed that the reverse of above generalisation also holds good, *viz.*, all big-leaved plants must necessarily be found in savannahs. Here, other factors also come into play, and, of course, in the struggle for existence, it is not one factor that counts, but the totality of all factors.

(ii) Juvenile leaves.

In this connection, one other important fact must be mentioned because it confirms the general trend of above argument. It is often observed that young trees or coppice shoots usually possess bigger leaves than the older tree. The significance of this contrivance is obvious, because it shows the extreme importance of exposing the greatest possible amount of leaf surface to the sun in the juvenile stage, which is the most critical in the life of a plant. It is then most exposed to suppression by grass, etc., and its life may be said to hang in the balance. This phenomenon is common to sal, and several other plants.

(iii) Leaf Orientation.

Some of these savannah plants acquire remarkable adaptations for exposing the maximum amount of leaf surface to light. Thus the leaves of *Macaranga denticulata* and *Clerodendron infortunatum* which are fixed to the main stem by long stalks, generally hang down vertically around the stem, the object being self-evident, *i.e.*, to cast as little shade as possible on the lower leaves. In the table given above, compound leaves have been considered as if they formed one continuous leaf lamina, instead of the separate lamina of each component leaflet, because the splitting of a compound leaf is only a convenient mechanism for obtaining maximum amount of light—this object being served by orientation of the leaflets at such angles as may be most suitable in reference to the incident light. It is conceivable that if the lamina were not so partitioned, it would become too bulky and too immobile to be easily oriented. Thus *semul* and *dhak*, *Butea frondosa* adjust their leaflets in reference to the position of the sun. This phenomenon, as also the phenomenon of 'sleep movements' is also met with in other than savannah species.

(iv) Phyllotaxy.

Another effective device common to many savannah species, is to arrange their leaves in different rows or tiers. The object, of course, is to reduce shading or overlapping, to the minimum. The leaves of *Callicarpa arborea*, *Clerodendron infortunatum*, *Ficus hispida*, etc., are, therefore, arranged in 4 vertical rows, of *Holar-*

rhena and *Eugenia* in 2 rows, while those of *Dillenia*, *Semecarpus* and *Careya* form a "high-ranked" spiral.

(*v*) *Elongation of leaf petioles.*

Still another device is to adopt a pyramidal system of throwing out leaves, so that the lower portions of a plant are not shielded by the upper. This is achieved in the case of young plants of *Clerodendron infortunatum* and *Macaranga denticulata*, by suitable elongation of leaf petioles, the latter gradually decreasing in length from the base of plant upwards.

B.—Protective arrangements.

(*i*) Ordinary adaptations, *e.g.*, hairs, waxy coating, etc.

On the other hand, the bigger the expanse of leaves, the greater the amount of water lost by the plant by transpiration. The savannah plants, therefore, must so adapt themselves that, while the leaf surface is not reduced, the danger of transpiration, a "necessary evil" in plant life is minimised. For this purpose, the savannah plants adopt all usual protective devices, which are very often met with in the common xerophytic desert plants, *e.g.*, *Zizyphus* species etc. Thus, nearly all of them possess thick coriaceous or leathery leaves, so that the risk of insolation is reduced. *Callicarpa*, *Clerodendron*, *Ficus hispida*, *Butea*, *Miliusa*, etc., are further protected by a covering of hairs, more particularly in their younger stages of life, when they require most protection. The leaves of *Macaranga* are polished above, and covered with red-dotted glaucous bloom on the under surface. The leaves of *Eugenia operculata* are more or less glossy or waxy, and so on, with other savannah plants.

(ii) *Leaf fall.*

Where heat is intense and these ordinary protective mechanisms would not suffice, the plant sheds its leaf, in the hot weather as a regular device to escape from the evil effects of excessive transpiration. From the point of view of grass, the evergreen species are most dangerous, and better fitted for struggle with them, than deciduous species, in that, they do not permit re-entry of grass. This explains why *Eugenia operculata* and sal are better competent to keep out grass than *semul* or *dhak*. For the same

reason, it becomes necessary to underplant teak, in order to preserve the factors of locality when it is deciduous, and to prevent the soil being overrun by grass or other noxious weeds.

(iii) *Red colouring of leaves.*

The most remarkable protective device which the savannah plants adopt is to turn or tint their leaves red either in the juvenile stage or at the time of leaf fall, or both. Thus the young leaves of above species of *Dillenia*, *Eugenia*, *Clerodendron*, *Shorea*, *Careya*, *Bischofia*, *Cassia*, etc., are very often some shade of red, and those of *Macaranga* and *Mallotus* covered with dense rusty tomentum. The exact significance of this anthocyan colouring is not known and not described, even in Jost's plant physiology. In the opinion of the writer it is, perhaps, one of the most effective protective arrangements with which nature has endowed a young delicate plant. The reason most probably is as follows. From the laws of physics, we know that the sun's light consists of seven colours ranging from red at one end of the spectrum, to violet at the other. Of these, red rays are known to be the heat rays, and the violet or ultra violet rays are the chemical or actinic rays, *i.e.*, rays most effective in photography. In the early stages of plant life, the young delicate leaves must be protected from heat rays, *i.e.*, excessive transpiration. Now, the best way to exclude heat rays or red rays is to let the light filter through a layer of red colouring, which, according to the laws of optics, absorbs complementary blue rays, and lets the injurious red heat rays pass out. It might be argued that although red rays have come out on the other side of the plant, they have passed through the leaf and have, therefore, heated the leaf in their passage. This is not true, because, light to be effective, must be absorbed. Thus, although the sun's rays pass through air, the atmosphere is not heated except by conduction or convection. A similar phenomenon, *i.e.*, adaptation of suitable colour has also been observed recently in several algæ (Gaidukow 1906, page 311 of Jost's Physiology). This chromatic adaptation, therefore, is, an important protective device among the savannah plants, because it keeps them cool. The red colour indeed, is nature's own way of protecting delicate leaves from excessive transpiration. As

may be expected, it is by no means confined to savannah plants, but occurs in other plants also, especially in plants which require protection from the hot sun in spring, *i.e.*, the mango, *Messua ferrea*, and *Quercus incana*, etc. The reason why this colour re-appears before leaf fall (as in *Eugenia operculata*, *Elacocarpus*, etc.), is similar. At the time of spring, the plant is very active, and is manufacturing and accumulating a large amount of food. It, therefore, absorbs and in fact demands a large influx of light, but at the time of autumn, the activity and energy of plant are at a low ebb; it is, therefore, necessary to reduce once more the intensity of heat rays, for which purpose the red filter re-appears. To put it in a more homely, though less accurate way, we can say that at the time of autumn, the plant leaf becomes very-much like a sick man (in fact, it may be said to be on death bed because it will be soon dead or shed). In this delicate state of health, what was once a wholesome food (*i.e.*, tropical or sub-tropical heat), becomes more or less a poison. The plant, therefore, by the habit, or call it, the accumulated experience of its forefathers, develops the protective red colouring—the object being to prolong the period of life as far as possible, in spite of scorching rays of sun.

There is still another and more significant reason why blood red colouring is very useful in the early formative phases of plant life. Plant physiology teaches that the rays of light which are most effective in producing growth are the blue rays in the same way, as red rays are most active in carbon-assimilation (P. 311, Jost). Now, when the leaves are young, it is most essential that they should be developed to their normal size as early as possible. At that stage, therefore, blue rays are most required, and this, as we have seen, is ensured by appearance of anthocyan colouring, which the chromatophores develop, in order to absorb blue light, as soon as the leaves aremature chlorophyll appears, and the leaves begin to absorb carbonic acid in the usual way, *i.e.*, by absorption of red rays in preference to other rays of the spectrum.

This would explain why young leaves or old leaves, as well as injured parts of leaves, become very often blood-stained although their normal colouring is green.

Evidently the red colour may have some other important function also, as attraction of insects, in the case of coloured flowers, but protection of young leaves from heat rays, and helping their growth and expansion, are two most important functions. In fact, red colour may be taken as a red signal signifying that the plant is subject to drought, though it is making every effort to overcome it.

C.—Resistance to fire damage.

The capacity to overcome fire injury is another obvious *desideratum*. The influence of fires is so well recognised, that it is not necessary to burden this point. The writer has prepared a table showing the bark thicknesses of these savannah plants but it is held back for want of space. From this it is apparent, that the abundance of a species in unprotected savannahs varies, among other things, directly as its bark thickness.

Thus *Careya arborea* is found in all savannahs because it possesses a thick mantle of bark which protects it from scorching, whereas *Macaranga* and its associate *Trema Orientalis* appear only in such places which are fire protected, because their bark is thin. The capacity to resist fire, therefore, plays a very important part in the local distribution and abundance of savannah plants in unprotected *tappars*.

D.—Miscellaneous.

There are several other minor factors to be considered, *e.g.*, lightness of seed, viability of seed, the immunity which a plant enjoys from grazing or otherwise, the power to die back and to recover, rate of growth, etc., but these factors are discussed in the silviculture of each of these species in Professor Troup's monumental work, and it is, therefore, unnecessary to repeat them.

E.—Conclusion.

The conclusion that follows is that the savannah plants, represent a highly specialised plant community, which, in the course of evolution have acquired several characteristic adaptations best suited for struggle against light-seeded, light-loving gregarious

grasses. These plants are essentially xerophytic like the ordinary desert plants, but they differ from the latter in this important respect that, while the desert plants have been trying to overcome transpiration by reduction of their leaf surface (*aphylly*, as it is sometimes called), the savannah plants, on the other hand, have been trying to develop as big leaf-laminæ as possible.

The bearing of this conclusion on practical forestry is simple, straightforward and significant. It follows that the greatest success in afforesting *tappars* and savannahs will be obtained with such species (enumerated above or their allied relatives) as possess very big leaves, the latter desirably possessing the power of producing anthocyan colouring, and are more or less evergeen, besides being fire-resistant, and hardy to climatic dangers like frost and drought. The actual selection of any particular species will depend on the local soil and climatic conditions. and such other factors as comparative rate of growth and economic value. No useful purpose, is, however, served by selecting for afforestation slow-growing, deciduous, short-leaved, tender species.

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THE FORESTS OF HESSE-DARMSTADT.

The following description of the forests of Hessen is in no way exhaustive, and is merely intended to pick out a few points of interest for Forest Officers who may visit the German forests. In order to make the account complete in itself, a few words on the Spessart forests in Bavaria and the Heidelberg forests in Baden are included, and all are conveniently reached by rail from Darmstadt.

The State of Hesse-Darmstadt lies on both sides of the Rhine and Maine rivers, and is sub-divided into three provinces, namely:—Starkenburg south of the Maine, and east of the Rhine, Oberhessen north of the Maine, and Rhinehessen west of the Rhine. The state has an area of 1,920,000 acres, of which the forests occupy. 619,000 aeres, and this area provides about half an acre per head

of population, or half what is required for their needs. The forests are to be found chiefly in the Starkenburg (42 per cent.), and Oberhessen (33 per cent.); Rhinehessen, being in the plain of the Rhine, having very few.

The ownership of the forests is divided between the State, Communes and Private owners, the majority (235,000 acres) belonging to Communes. State and Communal forests are under the charge of State appointed forest officers, but there is only a very general supervision of the Private forests by the State.

The distribution of species is equally divided between broad-leaved and coniferous, namely:—Scots pine 35 per cent. spruce 14 per cent. beech 35 per cent. oak 14 per cent. and miscellaneous 2 per cent. Originally the forests in the hills were composed mainly of oak and beech, so that all the present conifers have been introduced, chiefly owing to fears of a fuel famine a hundred years ago, when the introduction of a quicker growing species than beech was imperative. Now the area under beech is being reduced in favour of conifers, since conifers produce a higher percentage of timber than beech.

Hessen used to be famous for its oak coppice for tannin. But, owing to the introduction of myrobalans, quebracho and divi divi, the value of oak tanbark fell enormously, so that now all except the very best oak coppice is being converted to High Forest. For the calculation of the yield and the making of working plans, a modification of the Heyer volume method is employed. In this method each compartment is treated on its merits. Thus the actual and normal volumes are ascertained, from which the actual and normal increments are calculated. Then the yield is obtained from the formula:—

$$\text{Annual Yield} = Y = I_r + \frac{V_r - V_n}{a} \quad \left\{ \begin{array}{ll} \text{Where } I_r = \text{Actual mean annual Increment.} \\ V_r = \text{Actual Volume.} \\ V_n = \text{Normal Volume.} \\ a = \text{Period of Regeneration.} \end{array} \right.$$

Enumerations are carried out every 10 years. In these enumerations the forest must be carefully divided into subcompartments the basis of division being quality class (as indicated by the height growth relative to age), density of stocking, and species. From the local yield tables the height growth and age give

the quality class, and also the normal volume of the subcompartment. The actual volume is found by multiplying the normal volume by the density. From these data, the actual and normal mean annual increments are easily calculated, and thence the yield from Heyer's formula. Thinnings are not included in the yield, but are worked by area.

The yield as calculated above, is selected in the forest according to the following considerations, and in the following order :—

(1) Completion fellings on those areas already under regeneration.

(2) Fellings which are silviculturally necessary, or for protection.

(3) Stands which are giving a poor increment.

(4) Other mature stands.

This system of calculating the yield is generally employed throughout Hessen. As a result of this method, combined with the determination to utilise the soil to the fullest possible extent, the method of regeneration followed is by the "Kleine Fläsche Betrieb," or "Regeneration in Small Patches," so that regeneration is being carried out in small areas scattered all over the forest. As the object of management is to obtain the maximum yield in both volume and money, it is obvious that all those stands which are stagnating, namely, those with a deficient increment, should be cut out and replaced, probably by another species. So the forest officer goes through his forest selecting those areas which are worst, and regenerates these first, and as these may appear on quite small areas, he has to regenerate in groups.

In the Hessen beech forests, where they want to reduce the area under beech, the method works as follows:—Those beech stands which are giving the least increment are attacked first. Seeding and, later, intermediate fellings are made, so that beech natural regeneration is obtained in patches; elsewhere the canopy is kept dark. Gradually the remaining trees are removed and all the blank areas filled up with conifers, so that the ultimate result is a coniferous crop in a groundwork of beech.

This method of small areas is, therefore very intensive, since the whole forest may, more or less, be under regeneration, as the

small patches are scattered all over the forest. Consequently a skilled forest officer is required who knows his forest well. The method is not quite the same as the group system, partly because the fellings are not selected where there is natural regeneration already apparent, partly because artificial regeneration plays a large part, and lastly because the groups are not gradually enlarged until they coalesce.

The system has probably risen from the application of Heyer's formula, which is based on a comparison of normal and actual increments, as a result of which those areas with a low increment (which are sure to occur in patches) should obviously be cut, as they are not paying. The financial factors governing the method are that to obtain maximum yield in money and volume, it is necessary to utilise the soil to its maximum extent and not to let any crop giving a poor increment continue. Consequently each change in the soil, causing a change in the quality of the crop, probably needs a change in the species or rotation, so that each quality class has to be treated on its merits, resulting in regeneration in patches.

Silviculturally it should pay to work on small areas when seed years are frequent and light, so that regeneration fellings can be made annually, when side protection to the young growth is essential, and when soil conditions vary considerably over the forest.

In theory the above method appears quite sound, but, as it is applied in Hessen, the practical result is disappointing. The almost total absence of natural regeneration throughout the State is remarkable. The forest officers seem to have forgotten that to obtain good natural regeneration is one of the chief aims in forestry, while they have no pride in its attainment although such an accomplishment calls forth the highest skill of the forester. Nevertheless, the failure may partly be excused owing to the change of species now being carried out, and the consequent necessity of planting conifers among the beech groundwork. In spite of this extenuation, however, it appears that the art of obtaining beech natural regeneration has been lost to a great extent so that planting would anyhow be necessary. In excuse, it is

suggested that the soil is tired of beech, and this may possibly be the case. But in the case of Scots pine natural regeneration is also abandoned and artificial regeneration, usually by seedling planting (with or without the simultaneous raising of field crops), employed instead. And yet everywhere there are signs that natural regeneration could be obtained fairly easily. This is shown, by crops from 10—30 years old which were naturally regenerated, and by young growth everywhere coming in, which they fail to utilise. The method of small areas itself may, perhaps, be another cause of the disregard of natural regeneration, as attention is paid more to the crops which must cut, so that no loss of increment occurs, than to the problem of regeneration it being forgotten that the financial gain realised by the increased increment may be entirely counterbalanced by the increased cost of regeneration.

Anyhow the result is that nowhere is natural regeneration to be seen on any extensive scale under 10 or 15 years of age, while planting and sowing are everywhere to be found. The methods of sowing are, however, quite interesting.

The method known as "The ladder system" with its variations, is greatly used for sowing acorns. First the ground is prepared by removing the turf, or top three inches of litter, in strips nine inches broad and three feet apart. Then acorns are sown in these strips in bands, four acorns to each band or "rung" of the ladder, and these "rungs" are nine inches apart. The strips are usually prepared by hoeing, but they are sometimes made by a forest plough. The latter causes the lines to run very irregularly as the plough has to pass round all large stumps and any standing trees. Another variation of this system is to do away with the rungs, and to sow the acorns irregularly along each strip.

Broadcast sowings are also employed. The ground is first of all hoed all over. Then acorns are broadcasted, and these are covered over with soil by hoes and pressed down with the foot. This is possible as the first hoeing covers the ground with small hollows from each stroke of the hoe, into which the acorns naturally fall, and can then be easily covered over. Natural regeneration is held in various ways. Lines may be hoed three feet apart

along the contours to collect the seed, or turf removed in small patches by the hoe, or the area may even be hoed all over. All these methods are to get the seed in contact with the mineral soil, and if done in autumn the seed is pressed into the earth by the workmen as well.

In actual planting operations, perhaps the most interesting is planting combined with the raising of field crops. Usually there is only one field crop raised, but in the best soils two crops may be grown. In such cases the forest is planted the second year. (If Scots pine, as one year seedlings, if spruce, as one year transplants). The forest crop is sown in lines about three feet apart, and in between these the field crop usually potatoes, is planted.

All these methods of artificial regeneration are well and successfully done, but in each of them, especially in the methods of sowing, one is at once struck by the great expense involved, as it is all done so very thoroughly. The question arises whether, if they cannot obtain natural regeneration, they could not reduce sowing costs by less elaborate preparation of the soil, or by reducing the quantity of seed used, for the results are extraordinarily dense crops in practically every instance. The combination of forestry with field crops is especially valuable at the present time owing to the shortage of food in the country, and the return from these crops in some cases more than outweighs the cost of regeneration and weeding. On the other hand, the field crops undoubtably impoverish the soil to a considerable extent.

We now come to the areas under coppice. These are interesting in two main points. Firstly, in that in places regeneration of the coppice is combined with the raising of field crops. When the coppice is cut, everything is burnt. The ground is then hoed and field crops planted all round the stools, for about two years. This system is only being followed, owing to the shortage of food otherwise it results in too great an impoverishment of the soil, which is anyhow heavily taxed by the coppice, while the financial returns hardly cover the cost of formation.

The second interesting point is the conversion of coppice to High Forest. All those areas which fail to produce a given weight of tanbark per acre, are converted. The method of conversion is

direct, and consists in cutting the coppice and planting one year Scots pine seedlings on one year spruce transplants. This system necessitates cleaning of the stools for some years, which increases the expense considerably. One coppice shoot may be left on each stool, so as to obtain some tanbark at the first thinning. The method is distinctly "brutal," and it would have seemed preferable to let the coppice all grow up together, and then by judicious thinnings to leave all the best shoots at the end of the coppice rotation, so that the crop assumes the high forest state almost at once, and without any costs of formation. Their excuse for the planting method, however, is probably that they want to convert the coppice to a coniferous high forest, and not to keep it as oak.

The forests of Hesse-Darmstadt, therefore, are managed with the object of obtaining the maximum yield in volume and money, and are, with this end in view, regenerated by the "Kleine fläsche betrieb," method, or "Regeneration in small patches," and in the application of this scheme artificial regeneration plays a large part. So that it appears, that in Hessen, opinion now prefers artificial regeneration to natural, and the factors influencing this consideration seem to be :—

(1) The desirability of converting many of the existing beech forests to conifers.

(2) The result of using the "Kleine fläsche betrieb" method.

(3) Impatience, and the desire to regenerate every area as quickly as possible, so that no increment may be lost.

(4). Lack of skill, or "fatigue" of the soil for beech.

On visiting the forests of Hessen, therefore, the chief points of interest are firstly the "Kleine fläsche betrieb" method of regeneration. This system is best seen in the Heidelberg South forests, where the patches are not too small, the locality suitable to the system, and the forest seems to be worked very well. The extreme of the system may be seen at Heppenheim where, in places, the patches are absurdly small so that when the stands are mature there will only be one to five trees in each patch, and where there is a great multiplicity of species. Also in this connection the Viernheim forest is interesting in that the ground water level is used for the determination of the quality of the soil; for

instance where the water level is fairly high oak is planted, and where it is low Scots pine. To see how the working plan is made and applied the small Communal forest of Höchst in the Hetschbach range is ideal, as all stages are easily seen in one self contained block.

Secondly, regeneration of the forest crop combined with the cultivation of field crops is interesting. This is well shown at Eberstadt, where the system has been followed for forty years, so that all stages and results can be seen. Then at the forest of Ysenburg crops raised in this way can be compared with those raised naturally, and also with those raised artificially by planting.

Thirdly, methods are very well shown, especially in the Spessart, where the ladder system of acorn sowing with its variations, and various stages up to about 20 years of age are to be seen, also the broadcasting system, with or without an overhead shelterwood.

Fourthly, the coppice woods These can be seen quite well at Beerfelden, where conversion by the "brutal" method of planting is being vigorously carried out, and where the ordinary working of coppice, both with or without the simultaneous cultivation of field crops, is also being followed. In the Heidelberg North forests, however, the conversion by the French method of letting the coppice grow up leaving only the best shoots, and finally obtaining natural regeneration from these shoots when they are mature, is also very well shown in all stages.

The above are the chief points of interest in Hessen, but one must not expect to see forests managed in any classical system with natural regeneration as one of the chief objects. Natural regeneration is not only almost completely absent, but is regarded with great suspicion if by any chance it should appear.

F. C. O.

THE DIFFICULTIES OF A TOURING OFFICER IN THE SUBMONTANE FOREST DIVISION OF THE U. P., AND A POSSIBLE WAY OF IMPROVING THEM.

The difficulties experienced by the subordinate staff in securing means of transport and labour, both for touring officers, as well as for forest works in all the submontane Divisions from Saharanpur to Haldwani of the Western Circle, in the U. P., are very great. Its present extent I think, has not, even now, been fully realised.

The result is, that the subordinate staff is placed in a very awkward position and very often gets a bad name unjustly, on account of matters over which it has no control. In some places, the cartmen, camelmen, *Gujjars* (milkmen), coolies and forest shopkeepers are not only uncontrollable, but, probably on account of the freedom they have enjoyed in the past, have become very independent and the forest subordinate staff is really at their mercy. Nothing can be had at the current market rates by a touring officer, and he has to pay, whatever is demanded.

It will be unnecessary to quote actual cases, but a few general instances will not be out of place. For example a cartman may be earning at an average Rs. 2 to Rs. 3 per day or even less, but he may demand Rs. 2-8 to Rs. 5 per march, be it even less than five miles. A *Gujjar* or milkman may be selling his milk daily in local bazaars at 6 to 8 seers per rupee, which he has to carry himself long distances, but a touring officer on the spot can never expect to get more than 4 to 5 seers a rupee, and that too adulterated.

A cooly may be earning 6 to 8 annas a day elsewhere from the forest contractors, but he may demand double the usual rate from a forest officer or even refuse to work, knowing how helpless the officer is, and he has to pay whatever is demanded if he wants the work done. Similarly a forest shopkeeper may sell provisions at any rate he pleases. He may enhance the prices unreasonably above the local market rates, because there is no other man on the spot to compete him.

In spite of the fact that the above individuals may have no rights in forest settlement, most of them migrate from the colder

places in the hills to spend the winter profitably down in the submontane forests, while the plainsmen come from long distances, allured by the highest pay obtainable in forest works, than they can get elsewhere. They not only earn good wages in the forest, but they get in addition free fuel, grass and timber for the construction of their huts, and free grazing and lopping for their cattle.

There is no doubt that these migratory people are very useful to us, as most of the forest works, and our export, entirely depends on them, but, at the same time, they are also benefitted to such an extent, that it will not be easy for them to leave forest works on which they also entirely depend, for about eight months of the year.

In order to keep pace with the times, we should frame such rules which will not make it too unpleasant for these outsiders to take up forest works, but at the same time, the present difficulties of the forest staff which have reached an acute point should be removed.

On the other hand it looks wrong in principle, that these men who drive great benefits themselves, however useful they may be to us, should be given so much freedom, as to be out of control and troublesome.

I therefore submit the following proposals for consideration :--

It is obvious that the cartmen, camelmen, coolies, *Gujjars* and shopkeepers who come every year from various places to these forests during the working season for getting either labour and high wages or good grazing for their cattle (in the case of the *Gujjars*), come for their own benefit only, and not for the benefit of the Forest Department, and, to put certain reasonable restrictions on them will not be, in any way, a hardship.

I therefore suggest that cartmen and camelmen, intending to profit by the forest works, should be first of all licensed. The license fee being Re. 1 each, in the case of carts, and 8 annas in the case of a camel, for the whole season, and they should be allowed to work anywhere they like in the Division.

Along with the license, an agreement form, in triplicate, should be signed by the cartman or camelman,

The licenses and agreements will be issued in every Range Office, and the licensee will be supplied with a small tin plate with the name of the Division, Range, year, and serial number of the cart, or camel, licensed in that Range, impressed on each plate.

For instance, if the license is issued in the Haldwani Division, Jaulasal Range, in 1922-23, it would be sufficient to have a 4" × 3" tin plate, which would be fixed, in some prominent place on the cart.

While for camels, a circular plate 3" in diameter would be hung round the neck of each animal.

The agreement should bind the cartman or camelman to supply his cart or animal, so many times, to the Forest Department, during the working season, at definite rates, whenever required to do so, by the Range Officer, in whose Range, he happened to be working, at the time, and a suitable penalty for non-compliance should be inserted. The details could vary according to local circumstances.

One of the above forms will be given to the licensee as a receipt for payment, one will be sent along with the monthly cash accounts to the Divisional Office, and one will remain in the book at the Range Office for reference.

There may be some difficulty at the start, which is always the case, when a new system is introduced, but the scheme appears to to me to be workable.

As regards *Gujjars* (milkmen), coolies and shopkeepers who have no rights under the forest settlement, and who visit the forest in the working season only, similar agreements alone will meet the case, *i.e.*, that they will supply milk, provision and labour, etc., to the department at certain rates as fixed by the D. F. O from time to time, or as fixed by the Civil authorities, as is done now, in some places in the Eastern Circle.

Advantage of this agreement in the case of coolies must not be taken in forest works of permanent nature, such as markings, cultural operations, and road repairs, etc., which continue through out the season.

A certain number of days, three or four at the most, per cooly, per season, may be fixed, merely for urgent and unexpected works, or in cases of forest fires.

To make this system a success, a register will have to be maintained in every range, to see that the work has been equally distributed, and no individual has done more than his proper share, and also to keep control over the lower staff to avoid abuses.

M. HAKIM-UD-DIN, P.F.S.

SOME ASPECTS OF THE EXPLOITATION OF BAMBOOS IN THE U. P.

SIR,—In an article under the above title in the *Indian Forester* for April 1923, Mr. F. W. Champion asks for suggestions for a method of compelling bamboo contractors to cut the culms low.

Without any knowledge of the local conditions one cannot tell whether one's suggestion are practicable, nevertheless, I venture upon the following, as I am acquainted with certain areas in which it would be possible to work the measure proposed, and even if it is unsuited to the locality referred to by Mr. Champion, it may possibly be of use to some one else.

Obviously what is required is an inducement to the contractor to cut the bamboos as long as possible. For this purpose the leases might be on a monopoly system with a lump sum payment for the monopoly privilege, and further payments on actual quantities extracted at fixed prices per unit. Some such system was in force some years ago (perhaps still is) in, I think, Kheri, for the exploitation of timber.

The contractor would be allowed to fell and stack the bamboos, but not to remove them outside the forest until measured, passed and paid for. Different lengths would be stacked together and then passed by a responsible officer and billed for accordingly. The rates would be fixed in inverse ratio to length. Export would be past definite checking stations, at which all removals would be recorded, without reference to lengths, and any excess quantity so removed would have to be paid for at the highest rate, *i.e.*, that for the shortest length.

This system entails rather more supervision and check and therefore, more expense, but one cannot expect greater efficiency without greater outlay, and it is a matter for calculation whether

the improvement expected is commensurate with the extra cost involved.

C. E. C. FISCHER, I.F.S.

EXPERIMENTS WITH INDIAN TURPENTINE AT THE FOREST RESEARCH INSTITUTE, DEHRA DUN.

SIR,—In the recent issue of the *Indian Forester*, for May 1923, in an article entitled "A Visit to the Forest Research Institute, Dehra Dun," Mr. R. P. Dalley makes the following statement:—

"Another important discovery which will bring in lakhs of revenue to Government is the discovery, by Dr. Simonsen, the Forest Chemist, of the catalytic action of pyrogallol in preventing the oxidation of Indian turpentine. As a result of this discovery it will now be possible to advertise Indian Turpentine, Grade I, as equal in quality to the best American. The discovery will cost practically nothing to put into operation, but will make a marked difference to the revenue budgets of the Resin Factories."

This statement was published without my knowledge or consent, and goes far beyond what is at present justified by experimental evidence. In a short paper which I read (in collaboration with my assistant Mr. Gopal Rao) at the last meeting of the Indian Science Congress, it was shown that the rate of oxidation of d-Δ^{3}-carene, a constituent of Indian turpentine from the oleo-resin of *P. longifolia*, was very much reduced by the addition of a small quantity of pyrogallol. It was further stated that it was hoped by the addition of pyrogallol or some other catalyst to reduce the rate of oxidation of the so-called Indian Turpentine, Grade I, and so improve its keeping qualities. Experiments on this subject are still in progress, and are not sufficiently advanced to justify, the statement given in the paragraph quoted above.

I trust that Mr. Dalley's hopes will not be disappointed but I must definitely repudiate the discovery attributed to me.

J. L. SIMONSEN,

Forest Chemist,

often obtaining in Indian yards are indicated—logs lying on the ground half overgrown with weeds, and mingled with debris of bark chips, and decaying timber, forming ideal breeding grounds for fungi and insects and adding to the fire risks.

As regards the season of year for girdling, felling and conversion it is considered that if the log can be converted soon after it is felled, the time of cutting is of little importance as regards seasoning. If this is not possible the best time is generally between the end of the rains and middle of the cold weather. In the hot weather cracking and splitting may be excessive and in this period and in the rainy season insects and fungi are most to be feared. The best period for conversion depends on the nature of the timber, refractory woods require to be converted at the time when atmospheric conditions are least conducive to rapid drying and soft non-durable woods on the contrary when rapid drying will take place to prevent development of fungi spores. This indicates that the organisation of work in a sawmill in India might well aim at dealing both with hard and soft woods to give occupation for all seasons of the year.

The storage of logs will, under many conditions, remain an essential feature of Indian procedure, hence it is well that the best methods of treatment are discussed Complete storage under fresh water such as in log ponds is an ideal preventing splitting, cracking, insect attack, decay and staining; such however is often impossible, and in such cases, storage on skids with shelter from the sun and hot dry winds is recommended.

Of great importance is the question as to whether the bark of logs for storage should be removed or not. Barking logs increased the damage from cracking and splitting but its retention may involve severe depreciation by insect attack. Barking to be efficacious against insect attack must be done within a few days after the trees are felled. Lists are given of species which should be barked immediately after felling, and those which may be left unbarked, if the logs cannot be stored in a godown.

The final chapter of the record on damage to timber by insects is by C. F. C. Beeson, M.A., F.E.S., D.Sc., Forest Entomologist. It is based on observation of the timbers used in

the seasoning experiment, supplemented by sample logs kept in the insectary at Dehra Dun. The observations brought to notice numerous new species of borers and have given a mass of data concerning which preliminary notes are here given.

The important general points for the user of timber appear to be that owing to the irregular distribution of the borer pests a method of seasoning suitable in one locality may not be suitable in another. The season at which a tree is felled may materially affect the liability to damage. With few exceptions sapwood borers, heartwood or longicorn borers, shot hole and pin hole borers can be prevented, by removal of the bark, or by green conversion immediately after felling. Finally the damage is done within a period of 3—6 months from the commencement of attack, and beyond this period, is not affected either by the length of time the tree stands girdled, or the timber is held in the log, or by subsequent methods of treatment. It is the work of single broods, and is not extended by later broods of the same species.

The summary and general conclusions of this investigation may be given in full, in the hope that, the information may thereby be spread, and more may be induced to study the record (pp. 92 and 93).

If there is a point that a consumer of timber may be allowed to raise regarding this record, it is that an enquirer generally requires information regarding a particular timber. The record most admirably describes the investigation carried out and the results and conclusions drawn from them. But the enquirer has not time to peruse the two hundred odd pages of the two records in order to find out, what information is available regarding the timber in which he is interested It is suggested that leaflets should be published collecting together all the information on the various points for at least all the more important of the species concerned. These could be supplemented subsequently as our knowledge increases.

Those responsible for this record are to be sincerely congratulated, and users of timber will look forward to receiving further publications from Mr. C. V. Sweet, who has come from the U. S.

Forest Products Laboratory, Madison, to help us to solve our seasoning problems in India. Much is heard at present regarding the uncertainty of the future of the Forest Research Institute Dehra Dun, but with examples of such good work being done as is shown by this record, it is trusted that the valuable experimental work now in hand will not in any way be curtailed.

F. C.

NOTES ON THE FOREST COMMUNITIES OF THE GARHWAL HIMALAYA.

BY A. E. OSMASTON, I.F.S., JOURNAL OF ECOLOGY. X, NO. 2, NOVEMBER 1922, PP. 129—167.

We have here, in the author's own words, a first attempt to classify on purely ecological grounds, the forests of a portion of the Himalaya, actually the Garhwal civil district north of the Nayar Range, some 2,600 square miles..... in such a way as to link them up with the sub-tropical forests to the south, and the steppes of Thibet. As this introduction suggests, the treatment is somewhat technical, but the descriptive terms are practically all readily understood from the context without reference to Clements' ponderous volume on "Plant Succession" which is taken as model.

The writer emphasises (p. 131) the small effect of the subsoil on the composition of the forest though he finds that limestone is conspicuously characterised by the more xerophytic formations.

Five "climax" formations are recognised which, expressed in briefest terms, are characterised by alpine scrub, birch, mixed conifers, oak, and *chir* pine, in roughly successive altitudinal zones, the last two holding sway over 1,000 square miles or more, and the other three each, only about one-tenth of this area. Each of these five is then discussed in general terms, only the oak, with abundant moisture and moderate temperature being considered mesophytic and the others xerophytic in varying degree. The "associations which may be taken as meaning the types of forest as understood by the forester, are then considered for each climax formation: next the "consociations," or the gregarious dominant species constituting the association : and finally the "societies," comprising the

plants, mostly shrubs or small trees similarly dominating in the secondary stations (usually the lower canopy).

The arrangement is perhaps open to criticism, as it is necessary to hunt up three places to read, for example, all the author has to say about the vegetation of a *chir* forest: nicety of analysis has been preferred to convenience in reference. A map and eight plates, among which XIV, fig. 2, and XV, fig. 1, are the most suggestive, adequately illustrate the letterpress.

The facts presently imply a great deal of careful observation, and call for little comment. It is stated on page 155 that "So greatly is the composition and distribution of this *chir* association affected by annual fires, that it almost seems as if *the entire forest should be regarded as a sub-climax, and not as a climax at all*"—in other words, given prolonged and successful fire protection, the *chir* should ultimately be effectively ousted from its present dominant position, though it is not clearly indicated what is expected to take its place. Whilst admitting the very great effect of fire in the matter, one may be permitted to hold the view that *Pinus longifolia* would still remain entitled to the rank of an important consociation.

The writer is a little uncertain, and we think rightly so, about his *Anogeissus* association—it illustrates the common case where the extremes may be definite enough, but it is almost impossible to draw a line. The total absence of any reference to *sal* except in the section headings is presumably to be ascribed to absence of the *sal* association from the area discussed.

"Seral" communities (*i.e.*, transitory types) are very briefly disposed; actually they are not very common or conspicuous under conditions prevailing in these parts of the Himalaya, where generally either the climax has been reached, or man's influence has resulted in a reduction from it, and the great interest presented by this type of plant community in the submontane tracts is largely lacking.

A reader whose interest is primarily in forestry as opposed to pure botany, will probably conclude perusal with the thought that an exhaustive study of the ecological conditions affecting any of the species which form important forest crops, would be of more

value to him, but whilst admitting this, it may be asserted that an adequate comprehension of the whole, should precede the detailed investigation of the part. In conclusion, the paper is a valuable contribution to the literature on our Indian mountain forests, and it is to be regretted that, owing to its appearance in a home publication, it will be seen by but few in India.

C.

THE SECOND EDITION OF THE FAUNA OF BRITISH INDIA, BIRDS.

BY E. C. STUART BAKER.

(Vol. I.)

The well-known and excellent four volumes of the first edition of this work by Oates and Blanford were published between the years 1889 and 1898 and have now been out of print for some time, so that the appearance of a second edition would have been welcome had it been merely a reprint brought up to date, but it is much more than this, for the classification has been changed considerably in accordance with modern views, while the introduction of the tri-nomial nomenclature has rendered the original edition entirely obsolete.

Many field-naturalists were, and some probably still are opposed to this new nomenclature, for it was natural enough that those of us who had got used to the old names should resent the change until we had been convinced of its merits. Personally we were converted in May 1919 when an article by Mr. Stuart Baker appeared in the Bombay Natural History Society's Journal (Vol. XXVI, No. 2, page 518), entitled "Sub-species and the Field Naturalist," and here the case for tri-nomial nomenclature is so well made out that we would advise anyone who still resents the innovation to read it. A shorter explanation on the same lines appears in Mr. Stuart Baker's introduction to this volume. It will be a consolation to those who fear that the scrapping of old names and learning of new ones will go on indefinitely to read that "a time will soon come when we shall really have arrived at the bed-rock of nomenclatorial research."

As regards classification the author has endeavored to disturb Oates' arrangement as little as possible, but it is natural that there

should have been considerable changes of opinion in thirty years Classification is a subject on which we are not qualified to express an opinion, but we think that most field-naturalists will be glad to see groups so outwardly distinct as the Crows and Pies, the Tits and the Crow-tits raised to the rank of three separate families instead of being merely sub-families of the Corvidæ. The Bulbuls have also been put in a family by themselves and the Creepers and Wrens separated ; in all the number of passerine families has been increased from twenty-one to thirty-two.

The list of synonyms, which often extended to ten lines of print in the first edition, is here confined to one reference to the original description and one to the first edition. On the other hand much more space has been devoted to the habits, especially the nesting habits, of which the descriptions are very full and excellent. In this respect the second edition is a great advance on the first.

The illustrations in the text and those at the heading of each family which appeared in the original edition have been retained; in adition to these there are eight coloured plates by the author in this volume. If not works of art they are, at any rate, very vigorous and lifelike representations of the birds by a sportsman and naturalist who knows them well. It is probably a fault of the reproduction that the foliage, in some cases, appears a rather poisonous shade of green.

We have only noticed two misprints; "1,400 feet" for "14,000 feet" on page 25, line 23 and "canipons" for "canifrons" below Plate VII.

This volume, which is not quite so thick as the first volume of the old edition, deals with something like two-thirds of the species contained in the latter so that, at this rate, the work should be completed in about six volumes and the author hopes to bring out one volume about every two years.

E. O. S.

A SUCCESSFUL WOODEN RAILROAD.

Railroads with wooden rails have come into use for logging and other purposes, as a substitute for steel railroads, but have not

proved very practicable. The rails wear out rapidly, which is detrimental to the economy of the railroad, and besides these roads have not proved safe in working, owing to a strong tendency to derailment.

A wooden railroad not hampered with the above drawbacks can obviously compete in many cases with a steel railroad.

With the Widegren wood railroad now in use in Sweden these drawbacks are eliminated to the greatest possible extent. The wear of the rails is, for wood of ordinary hardness, practically none, and the danger of derailment may be considered as entirely excluded.

This distinct improvement in the wooden type of railroads has been attained by the introduction of an altogether new design of wheel. The wheels have no flanges, but are perfectly cylindrical and equipped with solid rubber tyres. To guide the wheels on the rails there has been introduced a special guiding device. This device guides automatically in each direction, without any tendency to fastening in the curves. The wheels can travel over the sharpest curves, and can pass even angles in the track, practically without any increase in rolling resistance and without the slightest tendency to derailing. Both rails are slightly sawn or hewed on the top, and one of them also at the sides.

Apart from having the advantage of slight wear of rails and of great safety in working, the design of wheel in question involves some distinct advantages regarding the construction of the track. The gauge need not be adjusted exactly, but can vary considerably, thus making it possible to use crooked logs as rails. Bends in the track need not be curved, but the logs are laid at angles to each other, so that the "curve," since it is formed by a suite of logs, will represent an open polygon. The construction of the track does not require any great accuracy or much skilled labour.

Further, it may be stated with regard to the construction of the track, that we have built our roads without making a road-bed, the rails being laid on trestles standing on cross-ties. Owing to the rigidity of the wooden rails, the trestles can be placed at

should have been considerable changes of opinion in thirty years Classification is a subject on which we are not qualified to express an opinion, but we think that most field-naturalists will be glad to see groups so outwardly distinct as the Crows and Pies, the Tits and the Crow-tits raised to the rank of three separate families instead of being merely sub-families of the Corvidæ. The Bulbuls have also been put in a family by themselves and the Creepers and Wrens separated ; in all the number of passerine families has been increased from twenty-one to thirty-two.

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E. O. S.

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THE FOREST DEPARTMENT AND THE 'AXE.'

Owing to the simple fact that it takes a considerable time to grow trees to exploitable size, no country can afford to rely for her timber supply on chance improvisation in case of dire necessity. Any mistakes once committed in handling the problems of a country's forests will take a very long time, perhaps centuries, to rectify. Hence it is very necessary in the interests of the country to examine closely the attacks of the Retrenchment Committee on the Forest Department, especially as the national aspect of forestry is hardly, if at all, realised in India.

In their attacks upon the Forest Department the Inchcape Committee have simply tried to emulate the example set before them by their prototype the "Geddes Committee" in England. Forest Conservancy is a great national investment as well as national insurance with great remunerative prospects, and

bringing the axe to bear upon it is simply trying to kill the goose which lays the golden egg. The British nation has never displayed any keenness for the conservation of her forest wealth, and used to rely upon foreign imports for her timber supplies till the Great War demonstrated the folly of such a course. And so it is not surprising to find the jettisoning of the Forest Departments in India and England. India has, in face of these facts all the more reason to be grateful to Lord Dalhousie for laying down a definite Forest Policy as far back as 1855. But the adoption by an administration of any policy does not mean the realisation of the true import of that policy by the nation, and it certainly did not mean that in the case of the policy of Forest Conservancy in India. Though, as a result of the labours of the Forest Department for over three-quarters of a century, India to-day occupies the position of the pioneer of forestry in the British Empire, there is no doubt that the utility of the forests to the nation is hardly recognised by us. Forest politics in India are in a frightfully low stage of development compared with the European countries, where forest problems occupy a definite position in a political party's programme, and the party's attitude towards the national forests goes a long way towards influencing its fate at the polls. We are, in India, far behind that state; even in England things are in no way better, in spite of the experience gained during the late war. But England is fortunate in having some redoubtable advocates of forestry like Lord Lovat, but for whose unflagging zeal and untiring efforts in the cause of forestry, the British Forestry Commission would have not been able to survive the throes of birth. In India there is not a single public man taking any active interest in forestry, the electorate is too ignorant to realise the great potential value of forests, there is not a single society which has for its object the furtherance of the cause of forestry, no forestry journal except the *Indian Forester**, is published. In face of these unpleasant facts, which bode ill for India's forest wealth, it is not surprising to find the

* There are, as far as we know, besides, three other forestry journals in India, at present, namely, "*The Madras Forest College Magazine*," "*The Burma Forest Magazine*,' edited respectively at Coimbatore and Pyinmana, and a weekly forest paper, recently started at Madras, called "*The Junglewallah*."—[Hon. Ed.]

work of the Forest Department, subjected to unwarranted hostile *criticism*.

It is not intended to rhapsodise here on the various advantages of forests, physical, social, economic, and political, but it may be mentioned that no country can afford to neglect her timber resources in modern times, where timber experts are predicting a famine in the near future. England is the only great nation to-day without adequate forests, but what she lacks at home, she has in her possessions abroad. The part played by the French forests during the Great War is little known outside France, and the position which the forests occupy in the French eyes can be judged from the fact that an individualistic nation like the French, has consented to an encroachment upon the individual's liberty in her Forest Code. The members of the French Academy write non-technical books upon the national utility of the forests, and deputies and members of the Senate take active interest in forest questions.

For about three-quarters of a century the Forest Department in India has been working under the most discouraging circumstances—the masses look upon the forest officers, who have to perform the thankless task of protecting the interests of future generations from being subordinated to the expediency of satisfying immediate popular clamour, as oppressors, the intelligentsia of the country regard them as needless, their work is hardly recognised, and they have to be content with thinking in terms of centuries, leaving it to future generations to recognise their work. And yet the record of their achievements constitutes one of the most glowing chapters in the history of British administration in India. Under these circumstances it hardly serves to ameliorate the unenviable position of forest officers to subject their work to such criticism as was made by the Retrenchment Committee.

Let us then examine the charges levelled against the Forest Department by the Retrenchment Committee. The first charge is that the Forest Department is not run on business lines. Now the area under the management of the Forest Department is

classified by the Government of India under the following four heads:—

(*a*) Forests whose preservation is necessary on physical of climatic grounds, *e.g.*, forests on water catchment areas, forests for prevention of denudation along hillsides, etc.

(*b*) Forests which supply valuable timbers, and in whose administration, returns form the main consideration.

(*c*) Minor forests mainly containing inferior species whose main object is to meet the local demands for fuel, timber, fodder, etc., in agricultural districts.

(*d*) Pasture lands which are merely grazing grounds under the management of the Forest Department.

In the case of the first of the above classes the indirect benefits of the forests far outweigh the direct benefits, as estimated from a commercial standpoint, and so it is impossible to manage such forests on strictly business lines. The great importance of such forests can be realised from the following anecdote. Owing to the destruction of forests serious floods occurred in the valley of the Rhone which endangered the safety of the neighbouring villages. Napoleon called the best engineering talent of France to devise some solution of the problem. The engineers after a careful survey of the locality submitted that, if all the wealth of the world were available it would not be sufficient to defray the expenses of the engineering construction necessary to check the floods. But the Forest Department came forward with a scheme for afforestation of the bare hills occasioning little expense. How far the forests created as a result of this scheme have mitigated the evil is too well known to need any comment. But in spite of their great importance it is impossible to estimate the benefits of such forests—" protected forests " as they are technically known—in terms of rupees, annas and pies.

The great importance of the third and the fourth classes can be realised from the following figures which show the amounts

of forest produce removed by right holders and free grantees in the year 1918-19:—

Timber	...	... 5 million cubic feet.
Firewood	...	... 80 " " "
Bamboos	...	... About Rs. 22,000 in value.

Grazing and fodder grass.—About Rs 38,000,000 in value. Most of the free grantees are poor people in villages not far from the forest, who depend for their very sustenance upon the products of the forest, and without which it would be impossible for them to eke out their miserable existence. In some cases small charges are made for the removal of forest produce, but they are only nominal. In times of famines these forests have to meet greater demands. Dr. Voelcker recognises the great importance of these forests in his recommendations for the improvement of agriculture in India. Thus the only forests whose management is on commercial lines are those belonging to the second class; even in their case the object of management is twofold—first conservation and improvement of forests and secondly the attainment of maximum net profits to the tax-payer, and one is as important as the other. In view of these facts it is absurd to assert that the Forest Department is not run as a commercial concern, it was never meant to be run like that and the utmost that it was to do, was to manage the forests under its charge in the most profitable way, as far as consistent with other demands; and it is not too much to say that in no country is so much stress laid on the profitability of afforestation schemes as in India—a fact clearly borne out by a comparative study of the proportions of expenditure to revenue in different countries. In Switzerland, for instance, the result is considered quite satisfactory if the forest administration can pay its way, whereas some of the forests are actually managed at a loss, and yet the Department is not "axed," simply because the indirect benefits accruing from forests, for example providing employment to so many people, insuring national safety in case of emergency like the late war, protection of land from denudation, etc., etc.,—are too well appreciated by the people as well as by the government. It must not be forgotten that according to the census of 1911, 1,585,464 people were

employed in India on forest work and industries depending on forest products, and if anything, the number must have increased considerably since then.

As all the above facts are of great importance in national economies, and yet cannot be ascribed any monetary value, financial results form a poor criterion with which to judge the work of the Forest Department. Still the financial results achieved constitute a harvest of no mean order as the following statement will show :—

Financial Results of Forest Administration in British India from 1864-65 to 1918-19 (in lakhs of rupees).

Quinquennial period.	Gross revenue average per annum.	Expenditure average per annum.	Surplus average per annum.	Percentage of surplus to gross.
	Lakhs.	Lakhs.	Lakhs.	Lakhs.
1864-65 to 1868-69	37·4	23·8	13·6	36·4
1869-70 to 1873-74	56·3	39·3	17·0	30·2
1874-75 to 1878-79	66·6	45·8	20·8	31·2
1879-80 to 1883-84	88·2	56·1	32·1	36·4
1884-85 to 1888-89	116·7	74·3	42·4	36·3
1889-90 to 1893-94	159·5	86·0	73·5	46·1
1894-95 to 1898-99	177·2	98·0	79·2	44·7
1899-00 to 1903-04	196·6	112·7	83·9	42·7
1904-05 to 1908-09	259·0	141·0	116·0	45·1
1909-10 to 1913-14	296·0	163·7	132·3	44·7
1914-15 to 1918-19	371·3	211·1	160·2	43·1

(Quinquennial Review of Forest Administration in British India for the period 1914-15 to 1918-19.)

The above figures need no comment, but it may be pointed out that all tending operations and other works of improvement,

which cannot be expected to give immediate returns, have been met out of revenue.

It is not intended to suggest that the Forest Management cannot be improved in many ways, but a wholesale condemnation of the Forest Department, as unbusinesslike is hardly justified by actual facts.

As regards the second proposal of the committee to place the Forest Department under timber trade expert, this step may ensure sound business, but it will at the same time gravely endanger the scientific management of forests. The risks of this proposal are well demonstrated by America, where during the early days of forest administration business considerations outweighed sound forest management with the inevitable result that America's forest resources are greatly deplected to-day. A business man can rarely rise above the petty consideration of profit, even when circumstances demand it. It is inconceivable that the afforestation of the denuded ravine lands of the United Provinces, or of the *chos* of Hoshiarpur could be entrusted to a timber trade expert, whose attitude towards forests, is bound to fluctuate with the vagaries of the timber market. It is interesting to note here that some eminent Frenchmen think that, even the minister in charge of the portfolio of forests must be a trained forester.

It is true that the business of marketing forest produce may be left to those who have a more intimate knowledge of the commercial world, and the inauguration of the utilisation branches in some provinces is a step in the direction of the division of functions indicated by such a principle. That such a division of functions has not yet been affected is due mainly to financial stringency, rather than to any reluctancy on the part of the Forest Department to accept the principle. But it is absurd to put a timber trade expert as the head of the Forest Department.

As regards the proposal to cut down the annual expenditure, which is mainly on the Forest Institute and certain minor administrations, it may be said that in the latter case, the expenditure is a mere business proposition, the initial outlay of which will be redeemed in due course, and every year's expenditure generally brings more than an equivalent amount of revenue,

besides leaving the forests in a highly improved condition, a word may be said as regards the former. The great importance of research in any science cannot be over emphasised, and that consideration applies to forestry in India with greater force, as in addition to assimilating the results of latest researches all over the world, there are certain problems peculiar to India which have to be solved here. In forestry nature has to be closely studied, followed, cajoled, and sometimes coerced. Now, that must necessarily be a tedious process, and it is the aim of research to devise short cuts to the ultimate goal. The gain in time and money which these short cuts ultimately yield cannot be over-estimated. It is hoped thata passion for pinchbeck economies will not be allowed to override the consideration that, expenditure on research is bound to prove, in the long run, the truest of economies. " The combination of research into problems of production and utilisation, if continued and encouraged, must result in a fuller realisation of our forest resources, which, after all, is the main object in view. "*

Financial strigency, reflected in indequate staff and ill equipment, is already retarding research work in the various branches, and if the cuts proposed in the forest expenditure are adopted, much of the very useful work now being done at the Central Institute will have to be stopped.

The Forest Department in India suffers from a peculiar handicap owing to lack of any assistance from scientific societies and universities of the country in the investigation of the many problems, such as is available in European countries, and consequently the field of its activities is very wide, and urgently needs further expansion. In her forests India possesses a national asset of great potential value which if properly managed without being restricted by the recommendation of a committee, which impatient for economy, had little time to consider the forest problems in all their diversity, will play a great part in her economic rejuveration. Experts predict a timber famine in the near future, but India need not entertain any apprehensions if the Indian Forest Department can only be extended proportionately to the

* Forest Research in India, 1921-22.

magnitude of the task before it. Paradoxical as it may seem, it is a fact that, India, with her quarter million square miles of forests, still imports timbers !!

Surely the Department which has, in addition to producing a net revenue of 22 million rupees in one year, fostered such flourishing industries as the resin industry, paper-pulp manufacture, match industry and many others, does not deserve to be 'axed."

S. A. VAHID, I.F.S.

THE INTERACTION BETWEEN *PINUS LONGIFOLIA.* (*CHIR*) AND ITS HABITAT IN THE KUMAON HILLS.

III.—THE EFFECT OF THE HABITAT ON THE GROWTH OF THE CHIR.

Just as difficulty is experienced in an analysis of the complex of factors deciding the restriction of the tree to a certain ascertainable distribution, to find out what are the real limiting factors, so also it is no easy task to decide what causes underlie the development and condition of any individual tree or group of trees. That condition can be described, and more or less obvious special features of the site can be noted, but to trace casual connections requires a very large amount of data and often difficult experiment. The forester's custom of distinguishing certain quality classes of locality—'locality' representing the sum of all the physical factors affecting the site of growth, is the result of the realisation that almost the only practical indication of the production capacity of a locality, is the produce. In other words, our knowledge is altogether inadequate to allow us to allot so many points each for altitude, aspect, subsoil, etc., and adding them up, to say the total is a measure of the productive capacity of the locality. The only type of analysis at present possible is that utilised by the writer in an examination of the influence of some of these same factors, on the rate of occlusion of resin channels (Champion[12]) by collecting a large number of data under a variety of conditions so selected that, there is a reasonable chance of cancelling out all variables but the one under examination.

In so far as general ocular observation goes, reference may be made to Troup's monograph (Troup[6], pp. 18—20) and the working plans for hill divisions. The essential points are dealt with below, and it has been found almost impossible to deal with the foregoing heads without occasionally including particulars more properly recorded here.

Rock.—As regards underlying rocks, different writers dealing with restricted areas have expressed different opinions as to which is the most favourable to the growth of *chir*, and the reasons for it.

Thus for Kumaon, Smythies[12] (p. 9) considers the tertiary Siwalik formations the best especially the middle Siwalik sand-rock; Osmaston[8] (p. 16) the older gneissic rocks; the present writer[18] (p. 15), limestone under certain conditions. It has however to be realised that the condition and the depth of the soil and subsoil are of much greater importance than the actual rocks below them, and really to a large extent the latter affects the growth only in so far as it is the parent of the soil. Troup[14] (p. 1045) summarising published information, avoids expressing an opinion as to which formation carries the finest *chir*, concurring in this view. Thus when it is asserted that gneiss is best suited to *chir*, what is to be understood is that, gneiss most frequently gives an optimum soil and subsoil. There are considerable grounds for thinking that the physical condition has a much greater effect than the chemical composition, most of the soils in question having a sufficiency of the requisite mineral constituents; this helps to explain the difference of opinion referred to, and the fact that *chir* grows well over a very wide range of rocks. Present opinion may be resummarised to the effect that among the old crystalline and highly metamorphic rocks, gneiss most frequently gives optimum conditions, whilst growth is also very good on the sandstones of the Siwalik formation.

Soil and Subsoil.—It has just been seen that other conditions being equal, the depth and physical condition of the soil and subsoil decide how far *chir* shall thrive in any given spot. It is a relatively deep rooted species, and it requires a reasonable depth in which to develop its root system at all satisfactorily, being able

at the same time to profit from an exceptional depth. It is also easily recognised that a light soil is preferred to a heavy one, and the tree does not thrive on stiff clayey soils such as sometimes occur in flat or poorly sloping places on most rocks. Since this inferiority is recognisable where there is any tendency for water to collect in excess and stagnate, it is clear that the real cause is lack of aeration rather than unsuitability on other grounds. So long as the depth is sufficient, a certain degree of stoniness does not appear to have any adverse effect. As regards actual soil moisture, a wide range is permissible without very much visible effect as *chir* of good growth may be found equally among the edge of permanent water streams, and on exposed slopes where the water-supply during the hot weather must be very restricted : but as noted where the water-supply is copious, it must not be at all stagnant.

To summarise, *chir* reaches its optimum development on a light soil of good depth, well drained and reasonably moist.

Aspect.—The direct effect of aspect, apart from the indirect effect working through connected variation in the soil, is again difficult to demonstrate. How far the moisture atmosphere and weaker light on the cooler northern slope balance the relative drought and strong insolation of the warmer southern aspect, cannot even be guessed. The best growth is on the whole found on the more sheltered aspects, but this is likely to be traceable to the soil once more. Possibly the rate of occasion of wounds may be an indication of the relative value to the tree of the several aspects, in which case north is best and south poorest (Champion[12], p. 15).

The heavy mortality which may be occasioned to young plants by a monsoon inadequate in amount or distribution has already been mentioned. The only record of direct injury from drought on older plants comes from a plantation (Champion[9], p. 171).

With its wide distribution in longitude and corresponding considerable variation in general climate especially as regards the amount and seasonal distribution of the rainfall, a variation in the botanical characters of the tree would almost be expected. No such have however yet been recorded.

Extraneous Influences.—The advent of man has interfered with nature's balance both between the locality and the *chir*, and between the *chir* and its competitors. This problem has been dealt with in the note already quoted (Champion[1]) and only the essential facts need be repeated. It is found that by burning the forests, the region which *chir* occupies without competition is extended upwards into the oak, laterally into all shallow ravines and hollows, and possibly also downwards into the sal and miscellaneous forests. At the same time its regeneration is very seriously restricted and injured, and open crops of inferior trees result with a parallel deterioration of the quality of the locality. Considerable areas have been totally disforested and twisted fibre becomes more prevalent. By felling and lopping, the young trees are largely destroyed, whilst excessive grazing and trampling render establishment of new seedlings increasingly difficult, so that this influence works in the same direction as the firing. Intense lopping may result locally in the replacement of *chir* by oak coppice.

IV.—THE EFFECT OF THE CHIR ON THE HABITAT.

On the Soil.—Chir shares with other pines, especially with the 2 and 3 needled forms, a rather low relative value as a soil producer. It gives a thick carpet of needles every year and abundant twigs, etc., but the carpet is very slow of decomposition when unmixed with broad leaved litter, and especially when dry. Mixed with oak it decomposes much more rapidly and gives an excellent humus and even the mixture with the low level deciduous species is fairly satisfactory in this respect. Through its excessive inflammability, a covering of *chir* needles exposes the soil to the danger (which commonly materialises) of frequent and severe fires with consequent destruction of undergrowth and humus, and drying out, though these fires return a great deal of the mineral salts to the soil in a readily accessible form, assisting the seedlings commencing growth a month or two later (Champion[16]. When fires do not occur or are excluded, a covering of *chir* undoubtedly improves the soil, especially the light soils on which it thrives best, and to some extent prepares the way for its own exclusion

by a more mesophytic and exacting flora. In such protected forests, the improvement even after the short period of 30—40 years is sufficient to raise the productive capacity of the soil very appreciably; Baldhoti plantation near Almora being a good example of this.

As a colonist occupying newly exposed soil and by covering it, preventing erosion, *chir* is quite good, and seedlings can usually be found on new land-slips, cuttings, etc., where the loose well-aerated soil allows of rapid development.

On Erosion.—The very high importance of the covering of *chir* forests in preventing the rapid erosion of the soil in the hills is very evident in any place where the cover has been removed, as in the vicinity of Almora town. In the latter areas, the heavy monsoon downpours result in very rapid erosion, and the productive capacity is reduced from good to extremely low or nil for agricultural or forest crops in a very short period of time. Conversely, if the devastating run-off is prevented by a soil covering, the moisture is soaked up, and maintains the flow of springs and streams, many of which originate in the *chir* zone. In this connection, the common belief of the Almora populace must be mentioned that the afforestation of the neighbouring hill-tops has resulted in a diminution of the water-flow from the springs. The explanation tendered is simple enough—the *chir* drinks up the water which would otherwise flow from the springs. There are no statistical data to shew the variation in flow, but if there be any basis for the belief, it is probably to be found in the undoubtedly greatly reduced run-off after showers, the check on which is interpreted as indicating a reduction in total outflow. This is not a suitable place for discussing the effect of forests on the total precipitation.

V.—The Effect of Forest Management on the Chir.

A relatively small proportion of the *chir* forests have been under systematic management for some 35 years (a few plantations etc., since 1875), and a much larger area for the last 10—15 years, so there has been time for this new influence to affect the condition of the forests, and the inter-species balance.

Fellings.—Large scale fellings have taken place under the two main systems of forest management, the selection and uniform systems. The former has varied considerably in the details of its execution, but in the main has resulted in the removal of the largest and best trees singly or in groups over large tracts, combined with almost invariably unsuccessful fire protection. These fellings have always been made with a high girth limit, at least 5 ft., and so except over small areas, plenty of trees were left to maintain the general soil cover and restock the gaps formed; hence such fellings have had but little permanent effect on the forest apart from a small reduction in the density and the removal of a number of large over-mature trees. The upset of the balance between reproduction and firing has been more disturbing than the actual fellings.

The results of the introduction of the uniform system have been very different and have had longer to shew themselves. As practiced in Kumaon, the chief difference has been that, whereas the selection system was mainly concentrated on the fellings, the uniform system has given primary attention to the regeneration. The selection fellings have been continued more or less regardless of whether regeneration was being obtained or not whilst for the uniform system, successful fire protection and adequate regeneration have rightly been considered as essential, and to a very satisfactory extent have been attained in the older reservations. The result has been the establishment of abundant regeneration in fairly even-aged groups of varying extent, in the almost entire disappearance of the very large overmature trees of the virgin forests, and in the creation of new type of forest composed entirely of young trees. The changes due entirely to fire protection have been omitted as far as possible, but it must be pointed out that where fire protection has not been successful, and the fellings too drastic, the result has been the more or less complete destruction of the forest *passim* after the 1921 fires; also parts of Khansargadh in Garhwal.

Fire Protection.—But the great change in the growth conditions introduced with forest management has been fire protection. One may assume that from the commencement of their

history, including the period before the advent of man, these forests were subject to occasional fires started by natural causes, with intervals of varying length, during which they were not burnt. The forests as we now see them however, must have grown up under much the same conditions as prevail at the present day with annual burning almost invariable—the oldest trees hardly reach 300 years, and 300 years ago Kumaon was practically as thoroughly settled as now. The introduction of fire protection was thus bound to have a very far-reaching influence on the vegetation with all its complex interrelationships. The visible effects on the *chir* forests are the filling up of all gaps and the general closing up of the canopy, the alteration of the stem form from that of the branchy wide-crowned trees typical of open stocked irregular forests, to the tall cylindrical bole and short crown of the tree which has grown up as part of a uniform group or crop.

It is self-evident and generally recognised that in some ways the introduction of fire protection actually increase the danger from fire, in that when from any cause a fire starts in a protected area, the accumulated needles, débris and often grass, give rise to a conflagration incomparably greater and more liable to injure the standing crop than the quiet fire of the annually burnt forest. It is recorded by Jerram[16] (p. 7). In this connection that in certain ranges in the Rawalpindi division, the forests have deteriorated since they came under regular management owing to periodic failures in the fire protection. The hazard is specially felt in newly protected areas where there is always more risk of fires being started by human activities and where often the cover is insufficiently dense to have cleared off all low branches and so restrict the fire to the conditions of a ground fire. At the same time it may be noted that the change is a return to primeval conditions.

It is difficult to analyse out the shares of the fire protection, and general protection, on the establishment of undergrowth in *chir* forests, but it is unquestionable that the part played by the exclusion of fire is a very important one.

Subsidiary cultural operations.—All modern working plans prescribed various operations to follow regeneration fellings, and

in the newly established crop, with the object of increasing the quality and uniformity of the latter. These usually begin with clearing up of the felling debris to reduce the fire hazard and improve the seed-bed, and lead up possibly, through sowing up of blanks, to cleanings and thinnings in the young crop ; every one of these operations is intended to, and undoubtedly does influence the growth of the latter. If sowings are made with seed not obtained from the same locality or collected from a type of tree not the prevalent one there, appreciable changes in the crop may occur, since modern research has established that other features in the parent trees may be passed on to their offspring (cf. Champion[17]). The importance of this with regard to twisted fibre is self-evident. It is again obvious that the tending operations in the young crops aiming at the elimination of all inferior stems, and the maintenance of a uniform canopy with optimum spacing for optimum development will also have a vast influence on the average stem in the crop raised by the forester as compared with the naturally grown crop ; this difference is visible after the shortest acquaintance with old and recent reservations.

General protection.—The results of the protection of the forest against all forms of injury have already been touched on and are dealt with in detail in the separate note already referred to. Unaccompanied by adequate management, it may result in a reduction of the area under *chir* by encouraging the establishment of an undergrowth in which *chir* cannot regenerate without assistance : given the necessary management, it helps towards the improvement of the crop from the forester's standpoint.

Resin tapping.—Of recent years the resin value of *chir* has come to outweigh by far its value as a timber produce in the Kumaon forests. Large areas which are totally unproductive as timber give a revenue, and a good one, through their resin and the importance of this product has frequently been the reason for the introduction of modern management, and even their retention as reserves. The resin industry has thus contributed greatly towards the improvement of the forests and a check on the destruction in progress, quite apart from any immediate revenue which may have been produced. On the other hand it must be admitted

that the introduction of resin operations has greatly increased the danger from the greatest menace of all to the continued existence and welfare of these forests, *i.e.*, fire, and the consequences are only too apparent, for, despite its wonderful powers of resistance, a tree bearing several open resin channels separated by narrow strips of living bark cannot be expected to survive a blaze which ignites the channels—as is usually the case. Examples are to be seen everywhere and the danger and damage are greatest for isolated standards among young regeneration, where everything may be killed. On the whole, however, the benefits conferred by the extension of resin work to the hill forests far exceed these drawbacks.

VI.—THE EFFECT OF FOREST MANAGEMENT ON THE HABITAT.

It is no easy matter to distinguish between the effects of management on the tree growth and on the locality since changes in the latter are usually recognised by the resultant effects on the former. The effects on the tree may thus be twofold—those exerted directly, and those acting through alterations brought about by the changes wrought in the habitat (primarily, the soil) in which it grows.

One of the aims of forest management is always the maintenance of a good soil-cover with inclusion, wherever possible, of trees which add markedly to the humus-content (such as *banj* oak) and, however imperfectly the object is attained, it must tend towards the improvement of the soil. The undoubted improvement of the soil in the Almora plantations already mentioned is good example of this.

As regards the influence in this direction of fire protection annually burnt *chir* forests away from the outer limits of distribution are practically devoid of all undergrowth, whereas protection always results in its establishment in varying degree, the overcrop, except in youth, being always sufficiently open to allow of it. This undergrowth must help towards improving the quality of the soil and so that of the locality though it may act as a hindrance to regeneration. The introduction of general protection acts in exactly the same direction.

VII.—CHIR AS A CLIMAX FORMATION.

We have finally to endeavour to forecast the final equilibrium of the reaction between tree and habitat as discussed in the foregoing paragraphs. It has been made clear that the destructive propensities of mankind have told heavily in the past, and are still doing so, on the *chir* forests, but that, the introduction of modern forestry methods is again turning the scale by doing all possible to encourage the species. The question accordingly comes up as to where the new equilibrium is likely to be. Would these forests now being protected from injurious external influences remain under *chir* without selective assistance against other species? If we do nothing more than protect, will other species find entry and oust the *chir*? In other terms, is *chir* forest the climax formation for these areas, the highest form of vegetation they can support? It has been brought out that all these influences act as dessicating agents, and, if they are checked, there is at once an initiation of a progression to a deeper or moister soil.

As regards the broad-leaved formation adjoining *chir* at low elevations, given such protection, *chir* seems likely to retreat before sal and the more mesophytic forms of the mixed deciduous forest, and to be usually only a stage towards them for the more xerophytic forms, though occasionally, it may be the climax for these last. At the upper elevations and in sheltered localities configuration has an important influence, and one reaches the decision that the oak, etc., will extend their range downwards quite appreciably, except where the erosive action of the rainfall on the soil ensures the maintenance of soil conditions too poor and shallow to enable them to oust the better adapted *chir*. A similar condition holds for sheltered hollows, and in both places *chir* instead of being a climax is only a stage towards a broad leaved forest.

The indications on the whole are then, that there is a limit to progress in this direction and that no other species is likely to displace *chir* from the central parts of its range, without a fundamental alteration in climate, *i.e.*, for these *chir* must be considered the climax formation.

H. G. CHAMPION, I.F.S.

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A NOTE ON SOUTH INDIAN LORANTHACEÆ AND THEIR HOST PLANTS.

The present note is the outcome of a study which the writer was induced to make two years ago during the course of his investigations into the cause of "spike" in sandal (*Santalum album*) with the object of finding out to what extent similar phenomena resembling spike occur in the case of *Loranthaceous* parasites. In the papers already published[1] it was pointed out that spike in the case of sandal is due to insufficiency of water to the plant owing to the death or removal of hosts or their otherwise being unfavourable. The study of *Loranthaceæ* was begun from this point of view, but for various reasons field observations of an extended nature could not be made and the writer had to confine his attention to the material existing in the herbarium at Coimbatore. The collection of *Loranthaceæ* here is specially valuable as host plants have been recorded in the majority of instances, a procedure which may sometimes be neglected by systematic collectors. Examination of the material yielded the list of hosts and their parasites which are recorded below and some tentative conclusions have been arrived at which will later be subjected to further proof.

Evidence for spike.—Among the species of *Loranthus* examined *L. cuneatus* and *L. longiflorus var falcata* gave indications of spike (*vide* figs. 1—4). In the case of the other species evidence was not so decisive as herbarium material could not provide 'diseased' or abnormal specimens in all cases. The actual death or removal of hosts does not arise in the case of *Loranths* as with sandal as the former attack perennial trees and shrubs which are not entirely killed by the parasite. The conditions

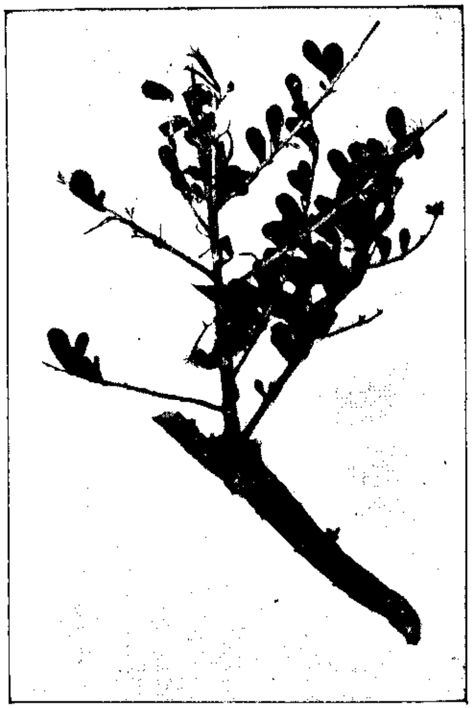


Fig. 1.

Fig. 2.

Loranthus cuneatus on 1. *Sophora glauca*, 2. *Dodonea viscosa*

Fig. 3.

Photos by M. S. Royan.

Fig. 4.

Loranthus longiflorus var. *falcata* on 1. *Azadirachta indica*, 2. *Albizzia amara*.

common to both which may lead to spike are the unsuitability of hosts and it is known in the case of the *Loranths* that the hosts undoubtedly exert an influence on the size and colour of leaves in the parasite so much so that the leaves fail to help in the identification of species. On this point[2] Koernicke in his valuable paper, "Biologische Studien an Loranthaceen," writes as follows:—

"........*der Wirt einen spezifischen Einfluss auf die Ausbildung des ihn befallenden Parasiten ausubt, sodass man "ernahrungs-physiologische Arten oder Rassen'" bezw. "Standort Varietaten" unterscheidet. So findet sich denn auch bei den javanischen Loranthaceen ein je nach der Wirtspflanze, vielleicht auch den Gegenden, oft ausserordentliches Schwanken im ausseren Habitus (Strauchausbildung, Blattgrosse,—Form und—Farbe), sodass, wenn nicht Bluten und Fruchte auf die Zugehorigkeit zu einer bestimmten Art hinwiesen, man versucht ware, wie es auch 'verscheidentlich geschah, neue Arten aufzustellen. Besonders "polymorph" sind nach Korthals bezw. Miquel ferner Molkenboer Viscum orientale, Viscun articulatum, Loranthus pentandrus."

Host plants.—An account of *Loranthaceæ* occurring in the Neilgherries was furnished by Bidie in 1874. The *Loranths* of Coimbatore District together with the hosts attacked by them formed the subject of a note by Fischer[3] in 1907 who also read a paper at the last Science Congress on the *Loranthaceæ* of South India which does not appear to have been published till now.[4] Mr. Fischer announced his list to contain 23 species with 6 varieties attacking 218 hosts, which must be a valuable contribution to the subject. The list appended below contains 68

* ...... the host is known to exercise a specific influence on the growth of the parasite, so here also one may have to distinguish local varieties, due to physiological changes due to nutrition, from real species or races.

In the Javanese *Loranthaceæ* one finds extraordinary variations in the external habit (changes of shape of shrub, size of leaves, form and colour) entirely due to the particular host, and also possibly to the district. These variations would often cause one to posit new species, except when the flowers or fruit point clearly to some definite species, indeed this confusion has already happened.

According to Korthals, Molkenboer and especially Miquel, *Viscum orientale Viscum articulatum*, *Loranthus pentandrus* are especially polymorphous. (Translated.)

hosts affected by 20 species to which may be added the following hosts observed by the writer some of which have been recorded by either Fischer or Koernicke.

Viscum sp. on *Thespesia populnea*, *Erythroxylon monogynum*, *Grewia tiliaefolia*, and *Loranthus* sp. on *Nyctanthes Arbor-tristis Odina Wodier*, *Euphorbia antiquorum*, *Phyllanthus Emblica Eucalyptus amygdalina*, *Salix babylonica*, *Aegle Marmelos*, *Citrus Aurantium* and *Casuarina equisetifolia*.

Affinity between Loranthaceæ and Santalaceæ.—Attention may be drawn to the fact that of the 68 hosts recorded in the list 19 are attacked by *Santalum* also by means of its roots *(vide* Appendix B). The same hosts being subject to the attack of *Loranthaceous* parasites on the one hand and of sandal on the other suggests in the first place a physiological affinity probably of an osmotic nature (cf. Harris and Lawrence)[5] between the parasites *Viscum*, *Loranthus* and *Santalum* and their susceptible hosts; and, secondly, a nearness of physiological relationship between the two parasitic families, *Santalaceæ* and *Loranthaceæ*, which on other grounds have been placed together in the systems of classification drawn up by Engler-Prantl and Bentham-Hooker.[6] The statistical evidence for this assumption may be briefly stated as follows :—

1. Taking Mr. Fischer's list of 1907 also into account the total number of families attacked by *Loranthaceæ* is 43 *(vide* Appendix C), out of which 30 are susceptible to *Santalum* also, according to the valuable list of hosts of sandal published by Rama Rao (1900),[7] who has incorporated that of Barber (1907).[8] It may be observed that of the remaining 13 the plants belonging to *Lineæ*, *Melastomaceæ* and *Elæagnaceæ* are stated as associates of sandal (which are probably attacked), and some of the others, *e.g.*, *Rhizophoreæ*, *Berberideæ*, *Rhododendron* and *Ilex* are of restricted distribution. Fischer's later list of 218 hosts, still unpublished, may throw further light on this point.

2. The number of hosts recorded by Rama Rao for sandal is 142 (excluding two unnamed ones), and these belong to 50 natural orders, of which 30 are attacked by *Loranths*. Of the

Fig. 5.

Viscum monoicum and *V. ramosissimum* on *Santalum album.*

Fig. 6.

V. monoicum and *V. articulatum* on *Santalum album.*

Fig. 9.

Loranthus loniceroides on *Ficus religiosa* showing phyllody.

remaining 20 it may be seen that 5 are among monocotyledons, and of the rest the *Begonias*, *Cucurbitas*, *Tinospora* (*Menispermaceæ*), *Asclepiadaceæ*, *Amarantaceæ* cannot for obvious reasons be parasitised by the *Loranthaceæ*. On the evidence so far available it appears that *sandal can attack several hosts which are affected by Loranthaceæ, though the converse is not true to the same extent.* The above figures and those for the genera and species are given in the following table :—

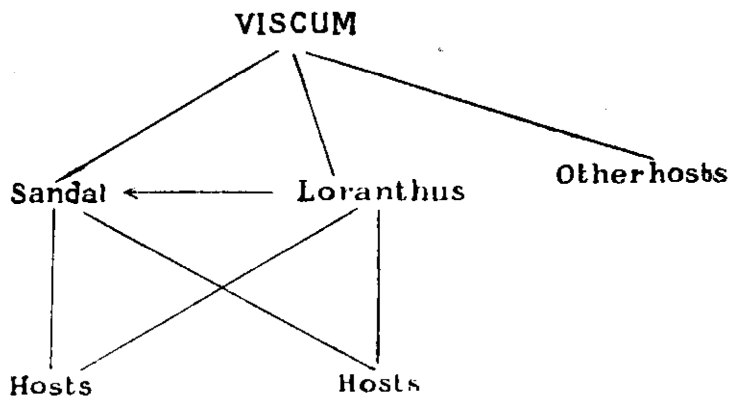
Number of Hosts attacked by

	Sandal alone.	Sandal and Loranthaceæ.	Loranthaceæ alone.	Total.
Families ...	20	30	13	63
Genera ...	87	30 (plus 15 ?)	46 (—15 ?)	163
Species ...	109	35 (plus 15 ?)	63 (—15 ?)	207

Viscum on Sandal.—The affinity suggested is also seen in sandal being parasitised by *Viscum*. Two specimens of special interest collected from Mysore (Somnathapur) have been noticed (*vide* figs. 5—6) in which the same twig of sandal has been attacked by *Viscum monoicum* and *V. ramosissimum* (the former towards the top) in one case and in the other by *V. monoicum* and *V. articulatum*. Rama Rao (1918) (9) noticed *V. verruculosum* and *Loranthus tomentosus* on sandal. The damage to sandal from *Viscum* or *Loranthus* is probably very little now, but it is suggested that the super-parasites may be kept in check and prevented from spreading.

Double parasitism.—This has been recorded by Fischer[10] for *V. capitellatum* on *L. tomentasus* and *L. longiflorus*. Among the specimens examined by the writer were *L. cuneatus* on *L. neelgherrensis* and *V. capitellatum* on *L. longiflorus var falcata* which was parasitic on *Salvadora persica*. Similar observations have been recorded in the case of some foreign *Loranthaceæ*. *Phoradendron californicum* for instance has been noticed on *P. flavescens* by Brown[11] (America), who suggests osmotic superiority for the former. Koernick's paper contains other instances.

The following scheme represents the parasitic relationship that exists among the genera *Viscum*, *Loranthus* and *Santalum* and their numerous hosts.



Phyllody.—Phyllody in *spiked trees* of sandal was first noticed by Barber (1903)[12] who characterised it as "one of the most puzzling parts of the disease." Among the *Loranthuses* examined the writer's attention was arrested by a fortunate specimen of *L. loniceroides* parasitic on *Ficus* Sp: collected by Rangachariar (1910), (*vide* Fig. 9) the word "phyllody" being written on the sheet. In view of the importance attached to the phenomenon by Barber, Butler (1903) and Coleman (1917) in the discussion bearing on the subject of spike in sandal, its occurrence in *Loranthaceæ*, whatever its cause, might prove to be of some interest.

I have to thank Rai Bahadur K. Rangachariar Avl. for special facilities extended in examining the herbarium collections.

P. S. JIVANNA RAO, M.A.

SANTALUM ALBUM, LINN. IN THE CHITOOR DISTRICT.

Appendix A.

Parasites.		*Hosts.*
1. Loranthus wallichianus	...	Cinnamomum Wightii.
2. L. intermedius	...	Cinnamomum zeylanicum.
3. L. obtusatus	...	Rhododendron arboreum.
4. L. scurrula	...	Dalbergia lanceolaria, Viburnum erubescens, Ligustrum neilgherrense, Vitex Negundo, Eleaagnus latifolia.
5. L. tomentosus	..	Desmodium rufescens, Acacia dealbata, Litseaa zeylanica, Viburnum erubescens.
6. L. recurvus	...	Eleaagnus latifolia, Glochidion sp.
7. L. cuneatus	..	Atalantia monophylla, Balsamodendron Berryi, Opilia amentacea Scutia indica, Dodoneaa viscosa, Sophora glauca, Acacia Melanoxylon, Wendlandia Notoniana. Ligustrum Roxburghii, Loranthus neelgherrensis, Glochidion tomentosum.
8. L. longiflorus	...	Balsamodendron Berryi, Lansium sp., Cassia siamea, Rhizophora sp., Gyrocarpus Jacquini, Bassia longifolia, Tectona grandis, Artocarpus integrifolia.
L. longiflorus var falcata,		Protium caudatum, Azadirachta indica, Zizyphus glabrata, Dalbergia spinosa, Dichrostachys cinerea, Acacia Suma, A. ferruginea, Albizzia amara, Salvadora persica, Stereospermum sp., Tectona grandis, Gyrocarpus Jacquini, Punica Granatum.
L. longiflorus var bicolor,		Acacia amara.

Parasites.		*Hosts.*
9. L. elasticus	...	Thespesia populnea, Citrus sp., Mangifera indica, Punica Granatum, Lantana sp., Myristica fragrans, Manihot Glaziovii, Ficus bengalensis.
10. L. neelgherrensis	..	Berberis aristata, Acacia Melanoxylon, Viburnum coriaceum, Viburnum erubescens, Ligustrum Roxburghii.
11. L. memecylifolius	...	Rhamnus Wightii, Daphniphyllum glaucescens, Rhododendron arboreum, Myrsine capitellata.
12. L. loniceroides	...	Eurya japonica, Acacia Melanoxylon, Terminalia tomentosa, Myrsine capitellata, Cinnamomum Wightii, Litseaa zeylanica, Ficus religiosa.
1. Viscum monoicum	...	Pongamia glabra, Albizzia amara, Punica Granatum, Wrightia tinctoria, Santalum album.
2. V. orientale	...	Helicteres Isora.
3. V. orbiculatum	...	Punica Granatum.
4. V. capitellatum	...	Rhizophora, Loranthus longiflorus var falcata.
5. V. ramosissimum	...	Rhus mysorensis, Santalum album.
6. V. angulatum	...	Opilia amentacea, Zizyphus xylopyrus.
7. V. articulatum	...	Diospyros Melanoxylon, Santalum album.
8. V. japonicum	...	Rhododendron arboreum, Eurya japonica, Ilex Wightiana, Ilex denticulata.

Appendix B.

F.-Fischer ; K-Koernicke; J-Author, S-attacked by Santalum also.

Natural Orders.	Hosts.	Parasites.
I. BERBERIDEÆ.		
	1. Berberis aristata ...	L. neelgherrensis.
II. TERNSTROEMIACEÆ.		
	2. Eurya japonica ...	L. loniceroides, V. japonicum.
(F) III. DIPTEROCARPEÆ (Shorea Talura)		
IV MALVACEÆ.		
	S. 3. Thespesia populnea,	L. elasticus.
V. STERCULIACEÆ.		
	4. Helciteres Isora ...	V. orientale, V. sp.
F & J. S. VI. TILIACEÆ (Grewia tiliæfolia).		
F & J, S. (?)VII. LINEÆ (Erythroxylon monogynum).		
VIII. RUTACEÆ		
	S. (?) 5. Atalantia monophylla ...	L. cuneatus.
	S 6. Citrus Aurantium ...	L. elasticus.
IX. BURSERACEÆ.		
	7. Balsamodendron Berryi ...	L. cuneatus, L. longiflorus.
	S. 8. Protium caudatum ...	L. longiflorus var falcatus.
X. MELIACEÆ.		
	9. Lansium sp. ...	L. longiflorus.
	S. 10. Azadirachta indica ...	L. longiflorus var falcatus.
XI. OLACINEÆ.		
	11. Opilia amentacea ...	L. cuneatus, V. angulatum.
XII. ILICINEÆ.		
	12. Ilex Wightiana ...	V. japonicum.
	13. Ilex denticulata ...	V. japonicum.
XIII. RHAMNEÆ.		
	S (?) 14. Scutia indica ...	L. cuneatus.
	15. Zizyphus glabrata ...	L. longiflorus var falcatus.

Natural Orders.	*Hosts.*	*Parasites.*
S (?)	16. Zizyphus xylopyrus ...	V. angulatum.
	17. Rhamnus Wightii ...	L. memecylifolius.
XIV. SAPINDACEÆ.		
S (?)	18. Dodoneaa viscosa ...	L. cuneatus.
XV. ANACARDIACEÆ.		
	19. Rhus mysorensis ...	V. ramosissimum.
S.	20. Mangifera indica ...	L. elasticus, L. sp.
XVI. LEGUMINOSÆ.		
S (?)	21. Dalbergia lanceolaria ...	L. scurrula.
	22. Dalbergia spinosa ...	L. longiflorus var falcatus.
	23. Desmodium rufescens ...	L. tomentosus.
S.	24. Pongamia glabra ..	V. monoicum.
	25. Sophora glauca ...	L. cuneatus.
S.	26. Cassia siamea ...	L. longiflorus.
	27. Dichrostachys cinerea ...	L. longiflorus var falcatus.
	28. Acacia dealbata ...	L. tomentosus.
	29. „ Melanoxylon ...	L. recurvus, L. neelgherrensis, L. loniceroides.
S.	30. „ Suma ...	L. longiflorus var falcatus.
S.	31. „ Intsia ...	L. sp., L. sp.
S (?)	32. „ ferruginea ...	L. longiflorus var falcatus.
	33. „ amara (?) ...	L. longiflorus var bicolor.
S.	34. Albizzia amara ...	L. longiflorus var falcata, V. monoicum.
XVII. RHIZOPHOREÆ		
	35. Rhizophora sp. ...	L. longiflorus, V. capitellatum, V. sp.
XVIII. COMBRETACEÆ.		
	36. Gyrocarpus Jacquini ...	L. longiflorus, L. longiflorus var falcatus.
	37. Terminalia tomentosa ...	L. loniceroides.
F. & J. XIX. MYRTACEÆ.		
(F) S (?) XX. MELASTOMACEÆ (Memecylon edule).		

Natural Orders.	*Hosts.*	*Parasites.*
XXI. LYTHRACEÆ.		
	38. Punica Granatum ...	L. longiflorus var falcatus, L. elasticus, L. sp., V. monoicum, V. orbiculatum.
XXII. CAPRIFOLIACEÆ.		
	39. Viburnum coriaceum var capitellata.	L. neelgherrensis.
	40. Viburnum erubescens ...	L. scurrula, L recurvus, L. neelgherrensis.
XXIII. RUBIACEÆ.		
	41. Wendlandia Notoniana ...	L. cuneatus.
XXIV. ERICACEÆ.		
	42. Rhododendron arboreum	L. obtusatus, L. memecylifolius, V. japonicum.
XXV. MYRSINEÆ.		
	43. Myrsine capitellata ..	L. memecylifolius, L. loniceroides.
XXVI. SAPOTACEÆ.		
	S. (?) 44. Bassia longifolia ...	L. longiflorus.
XXVII. EBENACEÆ.		
	S. (?) 45. Diospyros Melanoxylon	V. articulatum.
XXVIII. OLEACEÆ.		
	46. Ligustrum neelgherrense...	L. scurrula.
	47. Ligustrum Roxburghii ...	L. cuneatus, L neelgherrensis, L. sp.
XXIX. SALVADORACEÆ.		
	48. Salvadora persica ...	L. longiflorus var falcatus.
XXX. APOCYNACEÆ		
	S. 49. Wrightia tinctoria ..	V. monoicum.
(F) XXXI. S. BORAGINEÆ (Cordia.)		
XXXII. BIGNONIACEÆ.		
	50. Stereospermum sp. ...	L. longiflorus var falcatus.
XXXIII. VERBENACEÆ.		
	S. 51. Vitex Negundo ...	L. scurrula.
	S. 52. Lantana Camara ...	L. elasticus.
	S. 53. Tectona grandis ...	L. longiflorus, L. longiflorus var falcatus.

Natural Orders. *Hosts.*	*Parasites.*
XXXIV. MYRISTICACEÆ.	
54. Myristica fragrans ...	L. elasticus.
XXXV. LAURINEÆ.	
55. Cinnamomum zeylanicum	L. intermedius.
56. Cinnamomum Wighti ...	L. wallichianus, L. loniceroides.
S. 57. Litsea zeylanica ...	L. tomentosus, L. loniceroides.
XXXVI. ELEAGNACEÆ,	
58. Elæagnus latifolia ..	L. scurrula, L. recurvus.
XXXVII. LORANTHACEÆ.	
59. Loranthus neelgherrensis	L. cuneatus.
60. Loranthus longiflorus var falcatus.	L. sp., V. capitellatum.
XXXVIII. SANTALACEÆ.	
S. 61. Santalum album ...	V. monoicum, V. ramosissimum, V. articulatum.
XXXIX. EUPHORBIACEÆ	
62. Glochidion tomentosum ...	L. cuneatus.
63. Glochidion sp. ...	L. recurvus.
64. Daphniphyllum glaucescens	L. memecylifolius.
65. Manihot Glaziovii ...	L. elasticus.
XL. URTICACEÆ.	
S. 66. Artocarpus integrifolia	L. longiflorus, L. sp.
S. 67. Ficus bengalensis ...	L. elasticus.
S. 68. Ficus religiosa ...	L. loniceroides.
K. & J. S. XLI. CASUARINACEÆ (Casuarina equisetifolia).	
K. & J. XLII. SALICINEÆ (Salix babylonica).	

APPENDIX C.

FAMILIES AFFECTED BY

Sandal.		*Sandal and Loranthaceæ.*		*Loranthaceæ alone.*
Anonaceæ	...	Malvaceæ	...	Berberideæ.
Menispermaceæ	..	Sterculiaceæ	...	Ternstroemiaceæ
Cappárideæ	...	Tiliaceæ	...	Dipterocarpeæ
Geraniaceæ	...	Rutaceæ	...	Lineæ.
Celastreæ	...	Burseraceæ	...	Ilicineæ.
Simarubeæ	...	Meliaceæ	..	Rhizophoreæ.
Samydaceæ	...	Olacinæ	...	Melastomaceæ.
Cucurbitaceæ	...	Rhamneæ	...	Lythraceæ.
Begoniaceæ	...	Sapindaceæ	...	Caprifoliaceæ.
Cacteæ	...	Anacardiaceæ	...	Ericaceæ.
Araliaceæ	...	Leguminosæ	..	Myristicaceæ.
Cornaceæ	...	Combretaceæ	...	Elæagnaceæ.
Asclepiadeæ	...	Myrtaceæ	...	Loranthaceæ
Acanthaceæ	...	Rubiaceæ	...	
Amarantaceæ	...	Myrsineæ	...	13
Haemodoraceæ	...	Sapotaceæ	...	
Amaryllideæ	...	Ebenaceæ	...	
Palmeæ	...	Oleaceæ	...	
Cyperaceæ	...	Salvadoraceæ	...	
Gramineæ	...	Apocynaceæ	...	
20		Boragineæ	...	
		Bignoniaceæ	...	
		Verbenaceæ	...	
		Laurineæ	...	
		Santalaceæ	...	
		Euphorbiaceæ	...	
		Urticaceæ	...	
		Casuarinaceæ	...	
		Salicineæ	...	
		29		
		Liliaceæ (K)	...	
		30		

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SANTALUM ALBUM, LINN IN THE CHITTOOR DISTRICT.

Under the above heading a short note was published on pages 32 to 34 of the issue of the *Indian Forester* for January 1922. I have now again visited the scene of the experiment at Horsleykonda therein referred to.

I may recapitulate here that a number of sandal saplings growing on a tank bund, built up on sheet rock, were completely isolated from all other growth in September 1919, with the object of ascertaining how long they could survive without host plants. The whole bund has been kept clean weeded ever since, so that it is certain that the saplings cannot be parasitising any other vegetation, and they have been in that condition for nearly four years.

About July last year it was reported that the saplings under observation were showing signs of degeneration through this deprivation, and so I was anxious to see them again.

I now find that plants certainly have not the same healthy appearance; the leaves are narrower and are not bright green and many of the branchlets and twigs have dried up. But I cannot agree that this is unquestionably due to the saplings being deprived of hosts of other species, as I believe that their present condition is due mainly to the very severe drought of last year. From their very position these individuals are particularly exposed to suffer from drought, when the water level in the tank shrinks to almost nothing, as it did in the hot weather of 1922. This the photos accompanying my note quoted will show. Since recent rain several of the saplings have produced new leaves from the stems and close to the ground ; these new leaves have a quite healthy appearance. Further, a very large proportion of the sandal trees in the neighbourhood, even though located in more favourable moisture conditions and among suitable hosts, exhibit similar tokens of distress. In fact, it is practically only those in the most favourable conditions for obtaining moisture that appear really healthy. Another point is that, as the photographs show, the subjects of the experiment are growing far too close, and this alone would account for some of the discomfort.

I send this note now as it is improbable that I shall ever visit the experiment again, but I hope it will be continued to a definite conclusion and that the final result will be communicated to the *Indian Forester*.

In conclusion I may mention that all the seedlings, from seeds experimentally sown on the bare portions of the tank bund, but three have now died, and that there is no sign of 'spike' among these experimental plants or any other sandal in the locality.

C. E. C. FISCHER, I.F.S.

REVIEWS AND EXTRACTS.

TWO REPORTS ON FORESTRY IN KENYA COLONY AND IN UGANDA,

BY R. S. TROUP, C.I.E., I.F.S.

These reports are the outcome of a four months' visit to the Colonies of Central Africa by Prof. Troup in the autumn of 1921.

Severely practical in form they are written for officials and non-officials who are already well acquainted with the general physical characteristics and varied populations of this part of the globe. They would have been more enlightening to forest officers elsewhere if a few lines had been devoted to a short general description of the countries and their peoples, and to a brief history of the forest administration.

Both reports are written in practically the same form and are illustrated with useful maps.

I.—*The Kenya Report.*—From a perusal of it and of the map attached therewith it may be gathered that "more than three-fourths of the area of the colony consists of arid and sparsely-populated tracts covered largely with thornbush, where the amount of timber and firewood consumed is negligible." And so it is that, although there are 5,000 sq. miles of State forests and 100 sq. miles of private forests they merely cover 2·08 per cent. of the area of the colony. Only 3,207 . sq. miles of the State forests are administered at present.

Mombasa is the headquarters of a Coast Forest Division of 316 sq. miles—half of it mangrove creeks, the produce from which is carried in the form of poles by Arab traders to the Persian Gulf and South Arabia. Leaving the coastal belt the Uganda Railway climbs gradually through a stretch of nearly 300 miles of dry and savannah country, much of it infested with the tsetse-fly, to Nairobi (elevation about 5,000′) and thence in another stretch of 200 miles crosses the Highlands and the Rift valley and drops again to below 3,000′ at the Lake Victoria Nyanza. The remaining five Forest Divisions are all situated in the Highland and comprise nearly 2,900 sq. miles of administered forest in

blocks of large or considerable size, the biggest being those on the lower slopes of the two great volcanoes, Kenya and Elgon, and on the Aberdare Mountains.

Prof. Troup deals in an interesting manner with the different forest types of these uplands. They are essentially evergreen owing to a well-distributed but not necessarily heavy rainfall. In the mixed *Plateau forests,* typically represented near Nairobi, and situated on red laterite soil between 5,000′ and 6,500′, with a rainfall of about 40″ *Brachylaena Hutchinsii, Croton Elliottanus* and *Olea chrysophylla* appear to be the most typical among a number of strange species. The first and most important is a giant composite up to 100′ high with a long clean but much fluted hole, giving a hard fragrant durable timber resistant to termites and an excellent fuel. The natural regeneration of both it and the Croton is often plentiful.

The *Cedar forests,* in which the E. African pencil cedar *Juniperus procera* is the principal tree, are situated typically between 7—9,000′ with a somewhat higher rainfall than the last. The Juniper is a big tree and is associated with *Podocarpus gracilior* and two *Oleas* and many other species; the shrubs and herbaceous undergrowth are naturally denser than in the plateau type, but the forest is often intersected with grassy glades at the lower drier limits, and here fires have been very destructive. The cedar is also subject to severe damage from a fungus, *Fomes juniperimus*.

The third type is the *Temperate rain forests* which occur on the east slopes of Mt. Kenya, and the Aberdares, between 7—9,000′ and in a zone having a rainfall of at least 55″. The principal species in the lower half is *Octea usambarensis,* the so-called camphor, "an immense tree with a buttressed base and a clean cylindrical bole not uncommonly attaining a height of 120′ and a girth above the buttresses of over 30′. The timber is remarkable for its durability. *Podocarpus milanjianus* is also typical and reproduces itself freely under shade.

The last type to be mentioned is the *Bamboo forest* consisting of the one species *Arundinaria alpina* and occurring chiefly between 7,500′ and 10,000′—at its lower elevation as an under-

growth in tree forest, and above as a more or less continuous belt above the tree limit. This distribution is exactly similar to that of the *Arundinaria* spp. of the E. Himalayas where the pure *maling* forest is simply the result of fierce forest fires. The *A. alpina* appears to be a good deal bigger than the Indian species, being, it is said, from 30′ to 60′ high and 2″ to 4″ in diameter and covering the ground very densely in places.

The writer of the report lays stress on the need for preserving all the forest that has survived the grazing fires of the pastoral tribes, and the destructive clearing for temporary cultivation. No one who has seen the utter bareness of some of the hills of South Africa and realises the extreme difficulty and costliness of reafforesting large denuded areas of hilly country can doubt the absolute necessity for caution if only in the interests of the water-supply. Some of the settlers are already fully alive to the danger of the situation.

Fires which originate inside the reserves are also troublesome, the collection of honey being responsible for a good many as is the case elsewhere. The organisation of fire protection is evidently rather backward.

The proposals for the improvement of the management run on lines which are familiar to Indian forest officers. At the time of the author's visit the standing trees were marked under the rough form of selection fellings, but the royalties were charged on their estimated contents *before* they were felled! For purposes of exploitation the greater part of the accessible timber had been divided among timber concessions, some 30 or 40 in number, and conversion was being done almost entirely at sawmills. Prof. Troup remarks on the defective work in logging conversion and especially stacking after the latter and also on some serious defects in drawing up certain of the leases. There is only one long term lease extant, but this apparently covers 320 sq miles of valuable and accessible forest and runs on until 1958!

The *weak spot* in the management is the almost complete absence of working plans or schemes, and of maps to accompany them. A programme of work to cover 5 years is suggested and

comprises 1,664 sq. miles of topographical survey and working plans. One surveyor on £400 a year is already in the service and it is considered that with another added, the survey programme could be completed in the time. Retrenchment in India will perhaps make more than one officer available who has had experience of forest survey work if required.

It is proposed in the report that the D. F. O.'s draw up working plans for 504 sq. miles, and to employ two special working plan officers for the remainder. The writer considers that accurate topographical maps on a scale of not less than 2″ to the mile are needed. This is no doubt, the ideal, but unless the working is to be intensive, accurate modern maps on the 1″ scale should suffice.

In the discussion of the system of management it is made clear that many of the forests have been heavily worked by the selection of the best trees of valuable species and while excuses are found for this as a temporary measure a more conservative and rational method of treatment is advocated. More concentrated working is recommended but at the same time the forests are described as being irregular and the age-classes frequently mixed together. The method of clear-fellings in periodic block I, followed for the most part by artificial regeneration, and of selection fellings in the last three out of the remaining four periodic blocks of each working section is put forward for the principal method and notes are added regarding its applicability to the different types of forest already described.

No rotation is actually recommended but one of 100 years is mentioned as an example. No indication of the rate of growth of any of the principal species is given in the report, but on the analogy of the S. African *Podocarps* and associated species, 100 years would be too short except as a rotation of conversion.

In a variety of mixed Indian and Burmese forests the proposed method is indeed being introduced *by degrees*, but it cannot be said to be by any means of universal application as yet and particularly so in areas subject to damage by frost. There are many pitfalls and failures, there is a vast amount to be learnt about the growth of species at different stages, and the possible

mixtures and liability to attack by insects and fungi. The replanting of the cleared forest is gardening on a huge scale.

Moreover, a very considerable degree of devotion to duty is needed, in any but good climates, on the part of those officers who are called upon to reduce this form of treatment to practice. The results are likely to be proportionate to the effort exerted.

In one respect the Kenya Colony is fortunate, namely, that a considerable amount of tree-planting has been done already with the aid of temporary cultivation of maize and other crops, especially in the tracts near the railway where natural forest has been cleared for the fuel supply. It is reported that such "work is carried out efficiently and cheaply. The cost of clearing, planting and initial weeding works out at about £1 per acre, this being exclusive of the cost of staff and of raising plants in the nursery." Where the number of cultivators is too few to secure complete regeneration by means of field crops, an experiment is being made of planting in lines 10′ or 12′ apart (the spacing in the lines is not mentioned) cut through the undergrowth, and kept clear, until the plants are free from danger of suppression. According to our Indian experience, such wide spacing is likely to prove a failure with planting, as opposed to sowing thickly in broad lines, for the early closing of the canopy is the first and absolute essential consideration.

It has been stated above, that in certain types of forest natural regeneration is plentiful in parts, and obviously this will be taken account of when their turn for being cut over comes round.

An interesting note is given about the reproduction of the *Octea* forests. The huge overmature "camphor" trees are present, but there is a great deficiency in the lower girth classes and saplings and regeneration, and "artificial regeneration by seed is apparently out of the question since there is only one record of good seed having ever been collected, and that only in small quantity." Nature however seems to have solved her own problem, since even the largest stumps are able to produce a vigorous growth of suckers and stool shoots, capable of pushing through a heavy weed growth, especially where there is plenty of

overhead light, and of making an initial height growth of some 3' a year.

In former years many attempts were made to introduce exotics. Very few appear to have prospered, but some of the Eucalyptus, in particular *E. Globulus*, and other Australian trees are reported to have succeeded well. The importance of bringing in some fast growing species lies in the fact that there is neither coal nor oil in E. Africa, and wood fuel is an essential, for burning on the railway, and for other purposes. The fuel species ought therefore to have a good calorific value as well as rapid growth. The introduction of exotics on the whole is condemned.

It has been shown above that the forests of the Highlands are far from the coast, and the port of Mombasa again, is not exactly on a main ocean route. Whether there is really any surplus of timber for export is doubtful; if there is, than a large importer, S. Africa, is at hand. It seems however that very considerable quantities of teak from Burma, and coniferous wood from temperate zones, are imported already. The prices of indigenous timber at Nairobi are very high, all scantlings and planks of the better-class timbers ranging from 5 to 10 shillings per c. ft. although the Government royalties are only a small percentage of the working costs.

The report deals in detail with the possibility of creating a bamboo paper pulp industry in the Colony. There are three areas of 40 or 50 sq. miles each, which are now reasonably accessible, and suitable in other ways, but, while the supply of soda from local deposits is ample, that of limestone presents much more difficulty.

The last few pages of the report are devoted to a description of the financial condition and status of the Department, and to such essentials as a Forest Code, as well as to the staff and its improvement. Professor Troup rightly propounds that a quasi-commercial department should charge full royalties for produce supplied to all the Government Departments, by book transfer; otherwise the true financial position cannot be accurately assessed. The forests of the Colony are not being run at a profit at present, but, without giving details, the author states

that they are sufficiently valuable to produce, when fully brought under systematic management, a very considerable surplus.

The "gazetted" staff under the Conservator is in an anomalous condition, there being very few officers of 5 years' service, and in consequence, the administration has become too much centralised. A larger staff (of 17 officers) is proposed, and is evidently needed, including one research officer. Foresters are recruited and trained in the United Kingdom; they draw about half the pay of Assistant Conservators. Unless there is a misprint in the report, there are remarkably few posts of forest guards; these are natives of the country and are paid Rs. 12 per mensem and upwards.

The perusal of the report leaves the impression that, there is a great deal of solid work to be done in all the branches which comprise forest administration and management, so as to bring the Forest Department of Kenya Colony up to the standard of efficient working which is necessary for it to take its proper place as part of the permanent political and economic machine in E Africa There can be little doubt that a broad policy is wanted in order to make the Colony, and especially the Highlands permanently self-supporting in forest produce, after making full allowance for the expansion of the population.

II.—The Uganda Report.—This report of the forests of the protectorate is of less general interest to outside foresters than that of the Colony. The forests in both present similar features, but, as those now accessible in Uganda all appear to lie between about 3,000′ and 5,000′; (important tracts on the high mountains in the western district and on Mt. Elgon being outside the zone of the systematic working), they are necessarily of fewer types. The only important type of timber forest is the rain forests, which are confined to the vicinity of the great lakes, and of the mountain masses mentioned above. Of this there are various sub-types, and Prof. Troup describes the principal forests in some detail. From his descriptions it may be surmised that the principal timber trees in the hilly or undulating country are *Entandrophragma utile Khaaja anthotheca* and *Carapa grandiflora*, all with mahogany-

like wood, *Cynometra Alexandri*, *Symphonia globulifera* and several others, while along the low shore belt, and on the Islands of Lake Victoria, *Podocarpus gracilior* and *P. milanjianus* are common. In the associated swamp forests *Phœnix reclinata*, *Eugenia cariensis* and the *Raphia* palm are typical.

The other types are the *Savannah* and *Evergreen bush forests*, the first of which are very extensive, and of many different forms, with grasses of luxuriant growth varying from a foot or two in height to the tall dense "elephant grass." Periodical grass fires of great intensity prevent the survival of all but the most fire-resisting species of trees. The most important sub-type of savannah forest from the economic point of view is that in which the prevailing tree is *thamvule* (*Chlorophora excelsa*). The principal *mirile* tracts are situated in Busoga to the north of Lake Victoria, and are estimated to cover an area of about 700 sq. miles......Several fires have done immense damage to the trees which have been killed in great numbers.

Up to the time of Prof. Troup's visit the organisation for the systematic management of the Crown timber forests and their administration had been very backward, the superior staff extremely small and the work much centralised in the Chief Forestry Officer—so much so that, in 1921, all the forests had not been located with even tolerable accuracy, and the demarcation, survey and mapping, and methodical protection had been barely begun; no forests had been placed under working plans, and there were no forest divisions, as these are understood elsewhere. Three of the most accessible forests were being exploited departmentally and three other worked under leases, the terms of which, were defective in certain obvious ways; the defects, as the report states, being due mainly to the necessity for drafting some sort of agreement, the terms of which could be carried out by a numerical weak staff.

In both Kenya and Uganda there is the additional problem of the Native Forests, *i.e.*, those in the native reservations and (in Uganda) in the Baganda Kingdom. In this latter there are 300 sq. miles of forest in blocks of not exceeding ½ sq. mile in extent and entirely free from Government control. The Central Africans

require chiefly pole timber for their houses, and this can easily be produced under the coppice system with such indigenous species as *Dolichandrone platycalyx*, and exotics as certain Eucalyptus and perhaps wattles.

There is also the matter of native rights to produce from the Government forests. In regard to this it is stated that, "the Attorney-General has ruled that the right of natives to cut wood for building purposes under the 1907 Agreement is confined to wood used in the construction of native huts, and not of houses of European style."

Coupled with the general question of supplies of essential produce is that of wood fuel for the railway and steamer services. While there has been no special difficulty in past years, the future supply must be ensured, Uganda being even more awkwardly placed for obtaining coal and oil than Kenya, and so, plantations will have to be formed in convenient centres.

The author of the report proposes and discusses a 5-years' programme of surveys and working plans with a system of management, all of which are on similar lines to his proposals for the adjoining Colony; they have been sufficiently commented on above. The working plan programme is for 677 sq. miles. As the gazetted staff has been increased recently it is proposed that, simultaneously with the creation of four Divisions, the working plans shall, for the most part, be prepared by the Divisional Officers. This would be a comparatively simple matter for an experienced staff, but it is asking a lot of young officers unless the plans are merely simple schemes.

The Uganda forests are badly placed for both the import and export of timber. The only possible future market, outside the Kenya Colony, appears to be down the Nile. There would seem to be no need to think about this, until the organisation is placed upon a much sounder basis.

The agency of exploitation is discussed and decided in favour of departmental working, for one reason because the greater part of the timber removed is for supply to Government Departments.

Exploitation is evidently hampered, at the lower elevations in Kenya, by the presence of the tsetse-fly, which confines the means of extraction to mechanical methods such as tramways, in the Minzira forest on the Lake Victoria, and elsewhere, to man-haulage alone. This constitutes a severe handicap to the work.

Government Departments in the Protectorate receive their supplies of timber and other produce at reduced rates, and this makes the statement of financial results useless for the purpose of determining the true financial position of the Forest Department. Proposals are made to remedy this and to run the latter on strictly business lines.

Enough has been said to show that, although the forests are being cared for, the organisation is very backward. Prof. Troup has pointed out the lines along which improvement should be attempted, and while the whole prospect is less complex than that of the Kenya Colony, there is the same necessity to build a stronger foundation without delay, to eliminate wastage of the present stores of standing timber and other produce, and to make due preparation for future supplies.

R. C. M.

THE FOREST OFFICERS' HANDBOOK OF THE GOLD COAST, ASHANTI AND NORTHERN TERRITORIES.

By T. F. Chipp.

This excellently turned out little volume aims at providing a handy book of reference for Forest Officers and others interested in the welfare of these forests and also, by directing the study of Forest Officers to the main forestry problems of the country, at stimulating the service to produce a more complete and comprehensive compilation at a later date.

The author, after describing the country, its forests and how these are affected by climatic conditions goes on to discuss a forest policy and then gives the history of the Gold Coast Forest Department. After this, come some economic notes (very handily arranged) and a name—index to the flora (divided, after the

manner of a language dictionary, into a Botanical-native and a Native-botanical part). The concluding chapter is a sort of embryo Forest Manual giving the rules in force, and procedure for the sale of forest produce. An appendix on " Outfit and life on the Coast " and a very complete index completes what cannot fail to be a most valuable guide, full of well-produced maps, diagrams and botanical plates.

So much for the book from the point of view of those for whom it is primarily intended but to outsiders like ourselves it is full of interest to a degree that would hardly be expected of a mere manual of information. Perhaps the most striking, not to say sensational, thing in the book is the account, given in a long extract from Mr. Bovill's articles in the Journal of the *African Society*, of what is described, without exaggeration, as "the most amazing case of racial suicide, on a huge scale, that the world has ever seen," but the whole story of the progressive drying up of the country, the gradual encroachment of the desert and disappearance of the forest holds a particular interest for those of us who are accustomed to the reverse process, the gradual spread of evergreen species and the invasion of the dryer by the moister type under fire protection in North-Eastern India.

When we read of the destruction of these forests by shifting cultivation and of the abandoned fields filling up with forest of an inferior type, we cannot help feeling that the "*taungya*" system is the solution and wondering whether this is practicable and whether it has been tried.

It is a little disappointing to find no description of the fauna or game and to read the advice to new comers to bring only a shot gun on their first tour at any rate.

There is no mention of the healthiness, or otherwise, of the country which is somewhat, surprising, as most of the men we have met from these parts have been inclined to resent the popular reputation of the " white man's grave " and this omission rather suggests that the less said about health the better.

This is a book well worth reading whether the reader ever intends to visit the country or not.

E. O. S.

A NOTABLE CONTRIBUTION TO FOREST RESEARCH.

Announcement has just been made of the gift of $200,000 as an endowment for experimental research in forestry, this sum to be equally divided between the Yale School of Forestry and the Department of Forestry at Harvard. The gift is anonymous. The donor, it is stated, is deeply interested in the advance of forestry in the North-East, and especiallv in New England. The money has been granted in the belief that research and experiment in the field problems of forestry will do more than any other one thing to bring about forestry practice.

The need of forestry is now very generally recognised. The actual practice of forestry is retarded because of the limitations of our knowledge regarding the life and growth of our trees under different conditions and the lack of local experience in applying the methods of forestry. It is to supply the basic knowledge regarding the New England trees and forests and to enable more extensive field experiments in forest production, that the generous gift of $200,000 has been made.

The endowments have been given to Yale and Harvard because these institutions are already carrying on important work of research in connection with forests which they own or control. Yale has forest tracts in Connecticut, New Hampshire, and Vermont. The Harvard forest at Petersham, Massachusetts, constitutes a field experimental station of very great importance. Field experiments have been in progress on the Yale and Harvard forests for over fifteen years.

There are certain problems of forest research which can be worked out to a better advantage by a university than by any public agency. There are found on the technical staff of a large university men of great experience and technical knowledge. Such institutions are on a permanent basis and experiments can be carried out consistently over a considerable period of years And a university always has the advantage of being completely independent in its selection of projects and in the conduct of its investigations.

The donor of these endowment funds to Yale and Harvard has made a contribution to forest research of very great

importance, whose results should count large in advancing the practice of forestry.

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* THE CLASSIFICATION OF GOVERNMENT FORESTS IN INDIA.

A Constructive Criticism of the present Forest Policy with special reference to Bihar and Orissa.

Since the inauguration of the Forest Department in India each province has developed its own forest policy along independent lines. If a district forest officer in any province is to-day asked if he is perfectly satisfied with the general forest policy in his district, the answer in most cases will be a decided No, amplified perhaps by a description of how the various demands of the local

[* With one or two slight modifications this article was originally written as a paper for discussion by the Board of Forestry at their next meeting. As the latter has been indefinitely postponed, it has now been submitted for publication in the "*Indian Forester*," in the hope that it will invite discussion on and stimulate interest in an all too neglected subject.—HON. ED.]

population are pandered to at the expense of forest conservation and development owing either to the general forest policy pursued or to the prejudice, ignorance, or apathy of the revenue officials concerned. If such a criticism is just it follows that in most provinces either the general principles of forest administration are wrong or if their basis is correct they have been wrongly carried out. During the course of the last two or three years the writer has been struck by the extraordinary inconsistency and lack of foresight and balance which has characterised forest administration in his own province—Bihar and Orissa, and the following criticism has been written in the hope that if the experiences of other provinces have been similarly unfortunate, a joint endeavour will be made to secure that our present forest policies should be revised in the light of experience and placed on a sounder and more rational basis—a step which is of the utmost importance now at this critical stage in the history of India, when she is entering on the path of self-government and when she should not be asked to find her own way unaided out of the difficulties engendered by past mistakes.

2. The bulk of the Reserved Forests in Bihar and Orissa—Bengal as it then was—was reserved in 1878 and immediately succeeding years, the general principle observed being to reserve only large blocks of actual or potential value remote from populated centres. Subsequently, in their circular No. 22-5, dated 19th October 1894, the Government of India expressed the principles which they desired should be observed in the administration of all State forests in India. Their recommendations were that all valuable forest or forests the *preservation of which is essential* on climatic or physical ground should ordinarily be constitued Reserved Forests and that Minor Forest and waste lands should ordinarily be constituted Protected Forests. In conformation to this policy the Local Government took steps to notify as Protected Forest all forests, not being already Reserved Forests, which they considered should be conserved in perpetuity in the interest of the villagers. Of the forests so constituted some adjoined existing blocks of Reserved Forest while others formed isolated blocks of varying size surrounded by village lands.

3. In carrying out the policy of reservation small isolated villages or patches of cultivation were generally acquired and included in the area notified. Where the forests bordered on larger villages or groups of villages the boundary line of the Reserved Forests was so placed as to exclude large areas of forest for the use of the villagers or for the extension of their cultivation. Practically no rights were admitted. In carrying out the policy of constituting Protected Forests various curious artificial principles were employed of which two typical examples may be given In Palamau District the principle was in each village to allow for the extension of cultivation an area equal to that already under cultivation and to make the balance Protected Forest if it exceeded half a square mile in area. The results were that in a village with an area of, say, 3,000 acres, if only 125 acres were cultivated only another 125 acres were allowed for the extension of cultivation, but if 1,400 acres were under cultivation there would be no Protected Forest, because after allowing the tenants another 1,400 acres, the surplus area would be less than half a square mile. In the former case where the extension of cultivation would be desireable it would be hindered by the large area given to forest; in the latter case where forest protection would presumably be required, it would be impossible. In Angul District it was decided that an area of forest 20 chains in width should be left round existing cultivation for the use of the villagers. Now many of the Protected Forests in Angul occupy high precipitous hills and it is not unusual to find the Protected Forest boundary line wending its way in grim mockery along giddy heights a thousand feet or more above the village, and in extreme cases the summits of lofty hills may intervene between the boundaries and the villages. In all the Protected Forests rights of various kinds are recognised.

4. An exception to the general forest policy followed is afforded by the district of Sambalpur which from 1882 to 1905 was under the administration of the Central Provinces Government. In this district the policy followed was to reserve all forest, whether commercially valuable or not, whose permanent conservation was considered desirable. Subsequently, in 1908, after the

transfer of the district to Bengal, it was decided to reserve a few more forests which it was considered necessary to preserve permanently and to notify all other Government waste lands as Protected Forest with the declared object *not of preventing but of delaying their final extermination.*

5. Since the constitution of Reserved and Protected Forests the administrative policy pursued in all divisions except Sambalpur has been as follows in respect of each class. The Reserved Forests have nearly always been regarded as inviolable sanctuaries which could, it is true, be exploited for noble commercial ends but it was considered sacrilege to allow to be prostituted to any uses in the mere agricultural interests of the local people, however innocuous such uses might be. In the case of the Protected Forest however the aim has been to satisfy the rights and needs of rightholders either free or at reduced rates, the object being not to show a profit on management but to cover expenses. When the Protected Forests were first constituted no attempt was made to demarcate them. Simple rules were drawn up under which certain species of trees were either reserved or not permitted to be felled under a certain girth limit. The management of these forests was first vested in the Revenue Department. Subsequently it was found that if the forests were to be preserved from deterioration, demarcation and control by the Forest Department was essential. A remarkable phenomenon was further observed, and that was that if trees of certain girth only were reserved one obtained no permanent natural regeneration. The final result was the introduction of proper Working Schemes which aimed at regulating the removal of forest produce by rightholders, the surplus yield, if any, being disposed of each year in the open market. The situation to-day is therefore that the Reserved Forests, if they are worked at all, are worked on commercial lines mainly for the production of big timber, while the more important Protected Forests are worked under simple working schemes for the benefit of rightholders with commercial profits a secondary consideration.

6. In Sambalpur, although no rights were recognised at the time of reservation it has always been the object to manage the

reserved forests primarily to meet the demands of the local population at non-competitive rates and secondly to derive the maximum possible revenue from the surplus yield available after local demands have been satisfied. The Protected Forests in Sambalpur are under the Revenue Department, their management being vested in the village panchayats. They have never been demarcated and their exploitation is governed by rules reserving trees over a certain size. The objects of management are to conserve these forests for as long as possible with the minimum of interference from officials.

7. The results of the forest policy pursued can now be summarised as follows:—

(1) In settling the boundaries of both the Reserved and Protected Forests the general principle was to place them along hill slopes well above the level of the neighbouring villages. Now practically all the forest areas in Bihar and Orissa are hilly tracts in which the best forest is situated along the lower hill slopes or in the valleys. The results of the principles of demarcation were therefore to exclude large areas of the best forest, whether they were or were not fit for cultivation. Similarly where the Protected Forests border on Reserved Forests and intervene between the latter and cultivation it is not unusual to find that the Protected Forest contains better forest than the Reserved.

(2) The inclusion in the villages of large areas of valuable forest land unfit for permanent cultivation is an extraordinarily wasteful policy. The villager's method of exploiting a forest is extravagant and unscientific with the result that to meet his demands a much larger area of forest is necessary than would be the case if it were under scientific management. In a province such as Bihar and Orissa where the total area of State forest is far below the needs of the population the waste of forest property which is at present permitted is totally inexcusable.

(3) The idea that the mere constitution of a forest into a protected forest is sufficient to ensure its permanent preservation has been exploded. Experience has proved that Protected Forests, if they are to be prevented from ultimate destruction, must be demarcated and worked under regular working plans

which strictly regulate the exercise of rights. If this is done the only essential difference between a Reserved and a Protected Forest is that in the latter new rights can arise.

(4) In most Divisions the balancing of the budget for the Protected Forests depends on the disposal at competitive rates of the surplus yield. Now if new rights are allowed to arise it is obvious that the pressure of rightholders on the forest will tend so to increase that in time there will be no surplus yield at all. To balance the budget the rates paid by rightholders will have to be raised. Such result is totally unfair to the original rightholders. When a country is first colonised it is only fair that the original settlers should be granted some privileges with regard to the enjoyment of the forests surrounding their holdings. It is not only unnecessary and wasteful for the State to extend similar privileges to after-comers, but it is grossly unfair to the original settlers or their direct descendants to do so.

(5) The constitution of both Protected and Reserved Forests has increased the expenses of management. In one district Singhbhum, it has been found necessary to form a separate Forest Division embracing all the Protected Forests of the District. In other districts the expenses of management are increased by the upkeep of numerous boundary lines between the Protected and Reserved Forests.

(6) A system of forest management which aims at concentrating the production of big timber for commercial purposes in one area, the Reserved Forests and the production of small timber, fuel, fodder, etc., in another area, the Protected Forests, is economically unsound for, while it is possible to produce small timber and fuel only in one area, under no silvicultural system it is possible to produce big timber alone. Further, the factors of the locality vary considerably within the Reserved and Protected Forests. Some are suitable for producing big timber, others are not. The only rational economic system is therefore to work the forests as a whole, the requirements of the people in respect of forest produce being met from conveniently situated areas without any unnecessary prostitution of potentially valuable forests.

(7) The forest policy in Sambalpur whereby the demands of the people are met from the Reserves is giving admirable results. Not only is the revenue far greater than that in any other Division in the province, in proportion to the value of the forests, but the people obtain their requirements with equal if not greater facility than they do from Protected Forests elsewhere. The Sambalpur Protected Forests on the other hand only include forest of no permanent value and their ultimate destruction implies no waste of forest property. The present system of management is all that is required in their case.

8. It follows from what has been said that the 'Protected Forest' system has absolutely nothing to commend if it is intended that the forest so constituted should be permanently conserved. *If a forest is worth preserving it is worth reserving.* If a local demand has to be met or rights are admitted, then let the Reserved Forest be managed primarily in the interest of the local people and the rightholders, and secondarily with the object of obtaining the maximum revenue possible, consistent with the satisfaction of the demand or rights, provided always that the latter are neither injurious or excessive. Such, it is believed, has been the policy in the Central Provinces of which that in Sambalpur has been a legacy giving most successful results. Protected forests, if required at all, should be confined to areas of forest about whose permanent value there is some doubt, or to areas of forest, such as the protected forests of Sambalpur, whose ultimate disappearance may be regarded with equanimity. The former class of Protected Forest should be managed by the Forest Department until such time as a definite decision regarding its future can be reached and such decision should never be delayed long. The latter class of forest can be suitably managed by the Revenue Department, the advice of the Forest Department being invoked when required

9. If then it is admitted that a radical change in the present forest policy is required, how is this change going to be effected? The first step should be for the Forest Department to abandon its policy of splendid isolation with regard to the existing reserves and to throw them open to the people so that the requirements

of the latter in respect of forest produce, provided they are harmless, may be met. It is true that the forests in Bihar and Orissa have been so classified that in most cases the villagers require little or nothing from the reserves but there are instances to the contrary. For instance, in Palamau Reserved Forests no grazing of cattle is allowed although there is an intense demand for it. Now large areas of the existing Reserves were jhumed shortly before reservation 40 years ago and much of the present crop consists of pole forest. Despite the fact that during the last 30 years or so grazing, would have done little or no harm at all, in such areas it has been strictly prohibited through the blind prejudice of the provincial forest officials. The refusal to permit grazing is all the more remarkable in that the division itself has been run at a loss ever since it was constituted, and grazing would have afforded a useful source of revenue. In addition to showing the requirements of the villagers more consideration the Forest Department must endeavour to eliminate all waste of forest property at present under its management. Two examples of such waste may be instanced. Some years ago several villages surrounded by reserved forest in Sambalpur were acquired and reserved. Now although many of these villages contained forest at least equal in value to that in the surrounding reserve no attempt was made until two years ago to alter the original boundaries of the villages so as to include such areas of forest in the reserved forest proper. They were left to be destroyed by the villagers, oblivious of the fact that it was a far more economic policy to include them in the scientifically managed reserves proper and to give to the tenants free from the latter any forest produce they required. Singhbhum affords a still worse example of waste. In order to obtain labour a few forest villages were established, and instead of only giving the tenants a sufficient area of arable land large areas of surrounding fine *sal* forest were given them to be jhumed or otherwise destroyed. Yet we call ourselves Forest Officers! One or two Divisional Forest Officers in Singhbhum have indeed commented on the waste but not a single one has attempted to eliminate it although all that is required is a day or two's work with a prismatic compass. Is it surprising then that in view of

the ineptitude of the Forest Department to manage the reserved forests to the best advantage and its obstinate refusal to admit of the local people deriving any benefit from them at all, the Local Government has shown great hesitation in adding further to the existing area of Reserved Forest? Individual members of the Civil Service have, it is true, been strong advocates of a policy of further reservation but the Local Government has been biassed against it. To quote an instance, about 2½ years ago it was proposed in Sambalpur to reserve a few small areas of Protected Forest which it was considered should be permanently preserved and at the same time it was proposed to disforest a useless area of Reserved Forest. Both the proposals were backed up by the local Revenue officials. That for disforestment was sanctioned by Government with commendable rapidity; that for reservation seems to have been conveniently shelved as nothing further has been done. Such an attitude is due to prejudice pure and simple, and before it can be possible to carry out any large reservation schemes the Forest Department must endeavour to clear away the prejudices of the Local Government by proving itself more fit to be entrusted with the management of Reserved forests both in the interest of the local people and the general taxpayer.

10. The second step should be to obtain a revocation of the Forest Policy laid down by the Government of India in their Circular No. 22-S, dated 19th October 1894, in so far as the recommendations with regard to the constitution of Protected Forests are concerned. The forest policies pursued by the Local Governments must necessarily have been influenced by or based on that of the Government of India, and unless the Government of India admit that the policy advocated by them has proved a failure it is difficult to see how under present political conditions the existing provincial policies can be reversed. In some Provinces Forests are a transferred subject. Reservation of Protected Forests is bound to be a source of much agitation and it is doubtful whether any Minister would be willing to face the unpopularity which must attach to such a measure unless he were absolutely convinced of its urgency. In Bihar

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and Orissa the question is more complicated in that while the reserved forests are a reserved subject, the protected forests are a transferred subject. A wholesale scheme of reservation would involve the transference of the Protected Forests from the Indian Minister's control, a move which the Local Government for political reasons would be loath to make. It is obvious therefore that the first move must come from the Government of India. If in Bihar and Orissa alone has the present policy proved a failure then it is unreasonable to expect the Government of India to cancel its original policy. If, however, other provinces are similarly dissatisfied with the present policy (and as Bihar and Orissa was until recently amalgamated with Bengal it is probable that the policy in the latter province has similarly proved a failure) the sooner a joint effort is made to induce the Government of India to take action the better.

11. The third step should be to carry out a careful survey of all the State forests and waste lands and to decide which forest areas from either their local or national importance should be permanently conserved and reserved, and which areas should be left for the extension of cultivation or free enjoyment by the villagers. Now if all forests are reserved however big or small it is probable that many of them owing to their small size and isolation could only be run at a loss. Obviously if they are to be reserved on account of their commercial value they are in such a case not worth reserving at all. On the other hand if they are to be reserved on account of their local importance it is essential to reduce the working expenses to the smallest possible degree. In the writer's opinion the solution in the case of such forests is to constitute them into "village forests" and entrust their management to the village communities. The critics will say that such a scheme has been tried before and always proved a failure. Yes, but how has it been tried? The usual scheme has been to give the forest free to the villagers and deny them all right of making any profit out of its working. Now it is doubtful whether in Europe any communal forest could be run on such lines much less so in India where the advantages of forest conservation are little understood and where the only consideration which appeals to the average villager is that of 'pice.'

To get the ordinary village community in India to take an interest in any forest entrusted to its charge it is absolutely essential that it should be permitted to dispose of the product by sale and that it should pay Government a small rent for the lease of the forest. In Bihar and Orissa where the coppice system is almost universally applicable it should prove quite practicable for the Forest Department to hand over small blocks of forest to be worked by the villagers under a system of simple coppice. The Forest Department would first allot to surrounding villages a proportionate share of each block and it would then demarcate in each village area all the annual coupes. The latter would be worked in rotation by the villagers, control by the Forest Department being limited to occasional visits of inspection to see that any rules drawn up for working were being carried out. Each village would pay the Forest Department a small rent per acre which would help to cover the costs of supervision. It would also be at liberty to dispose of the whole annual yield by sale, certain rates if necessary being fixed by the department for forest produce sold to rightholders. In a district where village self-government has reached any stage at all there is nothing impracticable in such a scheme. Where money is involved each village can be trusted to protect its forest property properly, and the mere threat of resumption of management by the Forest Department would probably suffice to ensure the due execution of all the rules.

12. Finally, the writer would say that although he has passed a rather severe judgment on the present provincial forest policy the fact that the Forest Department has had to contend with great difficulties and frequently unjust criticism has not been forgotten. Excellent work has been and is being done but is capable of vast improvement. The duty of a Forest Officer is to manage the forest entrusted to his care in the best interests of the owner and to induce the owner to adopt an enlightened policy towards his forest property. This in India has not always been done. Is it too late to remedy past mistakes?

J. W. NICHOLSON, I.F.S.

NOTE ON THE AFFORESTATION OF GRASSY BLANKS IN SAL FORESTS.

Experiments have been going on for some years at the Central Institute on the above subject and it is now possible to give some fairly definite information, though the progress of work is not such that the results can be written up finally. The area chosen for experiment is a typical grassy blank in a sal forest some thirteen miles from Dehra Dun, with heavy frost and grass growing up to 8 and 10 ft. in the rains. On the area itself there were practically no trees with the exception of one or two odd stunted *semul*, etc., at very wide intervals.

2. The work was begun in 1916-17. It is unfortunate that the area was also used as a sort of second experimental garden. A large number of odd species were put out in Zabarkhet which were not really with the object of afforestation at all but merely to see the results of these species there as compared with the results at the Kaunli experimental garden. This unfortunately led to misunderstanding and many visitors wondered why anyone should experiment in a grassy frost hole with species known to be frost tender.

A further fault in the first experiments was that all were conducted in small beds and, even when partial success was obtained, it was not convincing to the local officer.

3. Practically speaking up to 1919, when the writer took over, the only conclusions came to were that several species could be raised but all needed intensive weeding during the rains. There were indications that possibly winter root and shoot cuttings of *Dalbergia Sissoo* and ordinary rains sowings of *Pinus longifolia* might survive with no rains weeding but the areas were too small and not convincing enough to start any real work as a result of them.

The United Provinces then informed this Institute that no solution which necessitated rains weeding was practicable over a large portion of the United Provinces as labour at that season was unobtainable, and experiments were then begun in which no rains weeding was permitted. Although this statement was

afterwards contradicted and it was stated that rains weeding was permissible it has now been again verbally modified and I am given to understand that rains weeding is still quite impracticable over large areas in many divisions.

4. In 1919 experiments over large areas were commenced in which no rains weeding was permitted and the area now under various species and methods is some 8½ acres.

So far as has been ascertained the only species experimented with which are worth considering for this purpose are *Dalbergia Sissoo* and *Pinus longifolia* both of which withstand frost and can be raised with no weeding in the rains.

5. *Dalbergia Sissoo.*

Sowings.—It is quite useless in heavy grass, so far as appears at present, to attempt to raise this species by sowings without rains weeding. With rains weeding it is perfectly simple by the usual methods of sowing. An experiment has even been made of ploughing the land, cleaning out all grass roots and then sowing *sissoo.* Although the plants came up so thick that they were like a field of wheat, although they were 6″ to 1′ high at the end of the first rains, although what grass there was was cut in the first cold weather, although the second rains the area was still full of *sissoo* apparently exceedingly healthy, although the grass was again cut the second winter, the area now at the beginning of the third growing season contains still some weedy looking *sissoo* not much higher than they were at the end of the first rains and which will undoubtedly peter out. It is true that with repeated sowings and a great deal of luck an unweeded *sissoo* sowing may get through but it is so much a matter of chance, and even then so patchy that as a practical method of grass land afforestation it may be ruled out unless weeded in the rains. It is moreover simply grass competition which has killed these plants, neither the frost nor damage by animals has had any appreciable effect.

Transplanting whole plants.—The experiments tried with unweeded transplants have not been a great success. It is possible they would succeed but the next method is so much easier and more certain that it is better to adopt it.

Transplanting root and shoot pruned transplants.—*Sissoo* are raised in a nursery and then planted out when about the thickness of one's thumb by cutting down the stem to 2" or 3" length and the root to 9" to 1 ft. taking care that the earth after transplanting comes up to the collar. The actual best length is not yet known but that length is quite adequate. The planting holes should be prepared some time beforehand and the bigger they are the better but about 9" diameter and 1 ft. to 18" deep is sufficient.

The dangers these *sissoo* cuttings will have to face are grass competition, drought in the hot weather, frost, up-rooting by pigs and grazing by wild animals.

Light frost will hardly affect the plants, heavier frost will kill the plants for some inches from the top and an exceptional frost will kill the plants to the ground but they will spring up again. This rather rules out *sissoo* in a bad frost area and, though *sissoo* is fairly frost hardy, *chir* is certainly preferable to it in such places. Grass competition need not be feared. It is preferable to cut the grass in the rains if it is practicable and in the cold weather if it cannot be done in the rains but in most grass areas it is not essential.

Drought in the hot weather is a danger and will be referred to more particularly under the next heads. When these root and shoot cuttings sprout they first send out leaves from the material stored in the planted "stick" and then manufacture roots. If sufficient roots have not been produced by the hot weather the plants will die and it has not been ascertained exactly how much root is necessary for the plants to survive—in any case it depends on the locality.

Damage by pigs and deer will be referred to later.

In all root and shoot cuttings nursery plants are preferable to those dug up from neighbouring forest and although success has been obtained here with such forest plants it has not been a sufficient success. This is probably largely due to exposure. A nursery can be on the spot and there need be no exposure of the root and shoot cuttings to the sun. A few hours exposure to hot sun will cause a lot of failures and must be avoided.

Winter transplants of root and shoot cuttings.—The object of this was to avoid grass competition. By cutting all grass in October or November, burning what was left and then putting out the transplants at the end of November or early in December it was hoped the new plants would be 3 ft. high by the beginning of the rains and thus get away above the grass from the start as the grass does not really commence to compete till the rains. The method, however, is probably not worth doing. It is perfectly true that if everything goes well it does succeed best of all but it is unlikely that everything will go well.

If there are no winter rains the plants will not sprout till late and there will be a large percentage of failures the first year. Sometimes only some 20 per cent. will succeed. If there are winter rains but no hot weather storms sprouting will begin in March and go on vigorously but root development will be insufficient and there will be a large amount of failure in the hot weather. Forty or more per cent. failure may result. If there are winter rains and regular hot weather storms then 90 per cent. may succeed and will be 3 ft. high before a rains transplant had commenced, but on the whole it is too much of a gamble on the weather and the next method is sufficiently certain.

Rains transplants of root and shoot cuttings.—This is exactly the same as before but the plants are put out when the rains break. They should be 3 ft. high by the end of the rains with good roots sufficient to carry them over the next hot weather. Whether grass is cut in the cold weather or not will depend on local circumstances. It is better to cut it but unless heavier than at Zabarkhet not absolutely essential. The rate of growth will vary largely with locality. The plants may be 3 ft. high the first year and 6 ft. the second but in Zabarkhet we have not managed this. They get 3 ft. high the first year but they then have rather a struggle and so far they are not yet really above the grass anywhere Sometimes too they will only get up a foot the first rains and that means a further struggle with the grass. The plants are undoubtedly being kept back by the frost. Sometimes they are killed to the ground, more often they are killed

a foot or more and though they will probably go through eventually they are at present much the same size as they were the first year.

6. *Pinus longifolia.*—This is the most successful species tried. The dangers it has to face are the same as for the *sissoo* but it seems quite unaffected by the frost and really only fears drought in the hot weather. So much so is this that it actually seems to prefer being unweeded which is exactly what is wanted. It is absolutely necessary to red lead the seeds before sowing or all will be eaten. An area here was tried by ploughing the land and clearing out all grass roots, sowing the *chir* in lines on the ploughed land early in July and no subsequent tending. This procedure is unnecessary and expensive and gives results no better than the line method.

In the line method lines about 9" wide were either ploughed through the grass or carefully hoed up. Hoeing is better but ploughing is good enough if the clods are broken up. Grass roots should be removed. The seed should be red leaded and sown thick 3" or 4" apart when the rains have properly broken here about July 1st. The *chir* will germinate in about 10 days or a fortnight and no weeding or clearing is necessary. The grass should not be cut the next year and when the young *chir* are a year old they will be 3" to 4" high. There will be a mortality from drought and it may be necessary to resow although it has been unnecessary in Zabarkhet. At the end of that rains the seedlings will be about 1 ft. high. A certain amount of judgment about grass cutting is now necessary. It is not necessary but it may be beneficial to cut the grass *between* the lines to prevent it simply falling over and crushing the young *chir* but it depends on the size and healthiness of the plants. By the time they are 2 years old they will be about 18" high. During the next cold weather grass cutting between the lines is certainly advisable and probably now necessary. When it is cut the *chir* which will often be very lanky and twisted in their effects to reach light from under the grass and may not have enough strength to stand up but this does not matter—they will straighten later.

The third year the best plants will be 3 ft. high and should then go straight through.

7. *Animals.*—Pigs are the worst. They root up a great many *sissoo*, but a *chir* area they will wipe out completely. Unfortunately the amount of damage they did was not realised till this year and there is no question that more of the failures in the *chir* here are due to pig than anything else, in fact the vast majority are pig. A pig will go down a line and root up every plant in a night. The area has now been fenced and fencing is absolutely essential to success if there are pigs about.

Deer also graze both *sissoo* and *chir*, they graze *sissoo* far more than *chir* but though, from this cause alone, fencing *may* not always be absolutely necessary it is certainly advisable.

8. It must be added that I cannot yet show anyone a flourishing *chir* forest. The area is only three years old and there are many blanks. But making due allowance for the pig with whom I was not competing, for I give him best every time, I think anyone will admit that this method solves the problem. Our friend the pig has still left enough plants to stock the area and as it is now fenced it should show a crop worth seeing in another couple of years. In case anyone is inclined to laugh at the idea of growing *chir* in the plains I may add that under this method *chir* can certainly stand a maximum of 110° in the shade and probably much more and seems to produce ultra first quality as regards rate of growth.

It comes to this. There is certainly a choice of two species when no rains weeding can be done, *chir*, and rains root and shoot cuttings of *sissoo*. But *chir* is unaffected by the frost here, whereas *sissoo* is affected though we have reason to believe it will get through. *Sissoo* ordinarily grows much faster than *chir*. If frost is bad I advise *chir* and not *sissoo*. If frost is not to be feared or is not very severe either *sissoo* or *chir* will do. If there is no frost at all *chir* will probably do but *sissoo* will get away quicker.

S. H. HOWARD,
Silviculturist.

3

A SHORT NOTE ON THE POPLAR (*POPULUS EUPHRATICA*) FORESTS IN MUZAFFARGARH DISTRICT, PUNJAB.

I.—DISTRIBUTION AND AREA.

Of the 9 poplar forests in Muzaffargarh District, 8 are situated along the left bank of the river Indus, while one is situated on the river Chenab, five forests are up-stream of Ghazighat, varying in distance from 1 to 16 miles from the Railhead, and 4 are down-stream of Ghazighat varying in distance from 35 to 75 miles. The area of these forests is as follows :—

Tehsil.	Name of forest.	Area.
Muzaffargarh ...	Qureshi	1,057 acres.
" ...	Sohni	692 "
" ...	Ranuja	1,322 "
" ...	Dandewala	931 "
" ...	Isanwala	7,142 "
	Total Muzaffargarh Tehsil ...	11,144 acres
Alipur ...	Bakaini	1,998 "
" ..	China Malana	4,248 "
" ...	Bet Dewan Sahib ...	3,178 "
" ...	Dammarwala	3,969 "
	Total Alipur Tehsil ...	12,493 acres.
	Grand Total ...	23,637 "

II.—PAST HISTORY AND SYSTEM OF MANAGEMENT.

These *rakhs* were once the waste land of the villages and according to the old customs considered to be the property of the Government. In 1861 an attempt was made to mark off plots

of waste land and to constitute them into Government *rakhs*. These were marked on the ground from 1874 to 1879, the remaining waste being given to the villages in which it was included. Sanction to this arrangement was received in Punjab Government letters Nos. 948, dated 20th August 1877, and 685, dated 1st June 1878. A record of rights was prepared for each *rakh* and the rights of Government secured in this manner. These forests were then managed under the rules published in Punjab Government Notification No. 94, dated 21st March 1882, printed at page 24 of the review prefixed to Mr. O'Brien's Settlement Report of the Muzaffargarh District, and were brought under the Forest Act on the 25th March 1907 and declared Protected Forests under Chapter IV of Indian Forest Act of 1878. The past description of the forest as given in 1905 is as follows :—

Isanwala ... Although there are some extensive blanks in this forest, a considerable portion is subject to periodical inundations and therefore admirably suited to poplar, which it produces at little or no cost.

Dandewala ... Do. do. do. But only a very small portion given to inundation.

Ranuja ... Do. do. do.

Sohni ... Somewhat like Isanwala both as regards utility and frequency of inundation.

Qureshi ... Do. do. do.

Bakaini ... Poplar in patches, some very large blanks, but on the whole not very badly stocked. Is not likely to improve much as it seldom gets any water from the river.

China Malana... Fairly well stocked with poplar intermixed with a few *sissoo*. Well suited for producing fuel. The only drawback to its being retained for this purpose is the frequency of fires that occur in this locality.

Dammarwala ...	Is well wooded on the east and south, but is scraggy towards the north and west. Its principal tree is poplar but there are lot of *kikar* (*Acacia arabica*) too along the south-east border.
Bet Dewan Sahib.	Densely covered with *kahi* grass (*Saccharum spontaneum*) which is constantly getting burnt. Some poplar trees in patches and a few *sissoo*.

Since 1905 these forests have further deteriorated on account of fires and lack of water, which has been brought about by the changing of the course of the streams and the control of water by the Canal Department.

During the past there has been no regular system of working. The forests were constantly burnt and the purchasers were allowed to remove the dead wind fallen and burnt trees ; but there are reasons to believe that quite a large number of green stems were also removed. On the system of management of that time Lt.-Col. H. P. P. Leigh, C.I.E., Commissioner, Multan Division, writes as follows : "The *rakhs* in charge of the Forest Department are maintained as timber reserves. The wood is cut and sold periodically and pieces of land are given occasionally for cultivation preparatory to converting them into plantations." The ruinous effect of forest fires is amply verified in Qureshi and Isanwala forests ; in the former quite a big area, which was apparently under a poplar crop, as is seen from the old dead stools is now covered with *kana* (*Saccharum Munja*) grass mixed with root-suckers of the species. In Isanwala, a vast area was seen covered with mature and over-mature trees killed by fire, and during 1922, no less than 70,000 cubic feet stacked of firewood were collected from there and supplied to the Railway Department. Such have been the effects of fires on these neglected forests.

III.—COMPOSITION AND CONDITION OF CROP.

It is a gregarious species and forms almost pure crop along the banks of the rivers or water channels, where the area gets flooded either occasionally or annually. Other conditions being favourable the state of the crop varies with the amount of moisture

available. The low depressions and other areas which get flooded, bear a better crop of poplar than dry localities which get water very seldom. In the latter places the *munj* grass (*Saccharum Munja*) forms a major portion of the crop and the tree remains very stunted, while in the former localities magnificent pure crops of poplar are found, where on a count of lack of light and abundance of water, *munj* grass is soon disappearing. In Qureshi and portions of Isanwala and Dandewala, where the areas are given to periodical inundations, we find dense pole crops with a height of 40′ to 60′ and girth of 2′ – 3′ in a period of 25 to 30 years. In these places *Saccharum Munja* has been altogether suppressed and is gradually disappearing. In major portions of Dammarwala, Bakaini and China Malana, where on account of the change in the course of the streams the areas are not influenced by river water, vast tracts of *kana* (*Saccharum Munja*) grass occur with a few shoots struggling here and there. Besides the above the wooded areas, which were once flooded and do not get water now, also bear a poor crop. The description of Dammarwala and China Malana written in the year 1905 widely differs from the present condition of the crop; which is quite poorly stocked as compared to the dense growth of poplar in the past. The deterioration of these forests has most probably been brought about by constant fires coupled with reduction of mositure due to changes in the course of streams, on whose banks they were situated and also control of water in the creeks by the Irrigation Department. As a result of fires on account of the presence of *kana* the whole tree-growth was swept away. It was then covered by profuse regeneration in places, where other conditions being favourable, the area was subject to periodical inundations or had sufficient moisture; while localities, which ceased getting enough water, became full of *kana*, which needs only a small quantity of moisture for its proper development. Dammarwala forest, which was once on the bank of the river Chenab, is now one mile from it, with the result that it does not get any flood water and the existing crop is deteriorating, while the re-stocking of the area has become rather doubtful. Now the forests on the whole, are nothing else but vast tracts of coarse grasses surrounded by narrow strip of

poplar along the outer boundary and interspersed with patches of poplar along the depressions. The outer belt of trees has survived the fires with the assistance of boundary lines, which have been kept clear from time to time and the interior patches with the help of flood water.

IV.—INJURIES TO WHICH THE CROP IS LIABLE.

(*a*) By far the most important danger to these forests is fire which in the past has swept away large areas of these forests and is still a standing menace to them.

(*b*) The rivers, by their mechanical action, erode away large portions of some of these forests. For example Bet Dewan Sahib has been reduced from 3,178 to a little over 1,000 acres during the floods of 1922 and China Malana has lost another 400 acres. There is no doubt that control of water by Inundation Canals has greatly reduced the damage by the rivers.

(*c*) The tree is also defoliated as was seen in March 1922. The specimen has been sent to England by the Research Institute, Dehra Dun, where it could not be identified.

(*d*) A sapwood borer has also been seen doing some damage to dry trees.

V.—FUTURE SYSTEM OF MANAGEMENT.

The regeneration of this species is not difficult at all, provided it is kept clear of *kana*, is protected against fire and gets annual floods. A scheme has recently been drafted by Mr. R. Parnell, Conservator of Forests, for the improvement of these *rakhs*. The 9 forests have been divided into 2 Blocks, one north of and the other south of Ghazighat Railway Station. The former will be taken up for regeneration, while the latter will be worked under supplementary operations till some more experience has been gained about the species and the means of transport have improved.

The exploitable age for poplar has been fixed at 30 years and 5 forests up-stream of Ghazighat have been divided into 2 felling series. 1/30th of the area in each felling series will be regenerated every year. The annual coupes will be started at

Qureshi on one side and Isanwala on the other, in such a manner that final cutting in each forest will commence against the direction of prevailing winds.

The regeneration operations are as follows :—

(1) Areas covered with *kana* grass with very little or no young poplar, will be burnt departmentally.

(2) In areas containing mature and over-mature crop of *sissoo* or poplar, seeding marking will be carried out and the felling refuse will be burnt. In case of areas covered with *sissoo*, ground will be trenched and areas covered with poplar will be ploughed if necessary, to induce root-suckers.

(3) The pole crops of *sissoo* or poplar, or of both the species mixed together, will be thinned. The intensity of thinning will vary with the locality and condition of the crop. The danger of trees bending over, if too suddenly isolated, should not be lost sight of.

(4) Areas covered with young shoots and dense *kana* will be burnt and *kana* stubbed out. It may prove desirable to stub out *kana* in plots, where the shoots are dense and *kana* is scanty.

VI.—SUPPLEMENTARY OPERATIONS IN AREAS UNDER REGENERATION.

(1) In areas where seeding marking has been done, all *kana* will be kept in check by stubbing and burning individual clumps, as they become a nuisance and interfere with young tree growth. Dead and dying trees will be removed annually. When the new crop is fully established, the overwood will be removed entirely, this will probably be within 5 years of commencing regeneration operations.

(2) In pole crops, *kana* grass will be watched and kept in check by stubbing where necessary. Dead trees will be removed annually.

(3) In areas where the crop has been burnt and *kana* stubbed out, watch should be kept, until the new crop is well established, to see that *kana* does not again become a nuisance.

(4) Biennial departmental burning of areas covered with *kana* with very little and often no young poplar will be continued until such time as the new crop in other parts has been freed from damage by *kana* grass. During that time some method would have been found to artificially regenerate the area, if it has not already been stocked by saving whatever shoots have come up, in every subsequent burning.

(5) Clearing will be carried out in young regeneration, when between 2 and 5 years old, in order to cause acceleration in diameter and height growth.

(6) In the 10th, 20th and 25th a year of the rotation, it will almost certainly be desirable to thin out the young poplar crops. Thinning will be so carried out as to get timber in the end of the rotation.

(7) Any permanent fire lines will of course be kept clean throughout the rotation.

VI.—SUPPLEMENTARY OPERATIONS IN AREAS NOT UNDER REGENERATION.

(1) Areas covered with *kana* with very little and often no young poplar will be departmentally burnt by clearing guide lines round them.

(2) Fire lines will be made to split up large compact block of areas bearing promising poplar crops into 50 or 60 acres plots.

(3) Where produce can be marketed, all dead and wind fallen trees should be removed ; for this purpose a 4-years felling cycle might be adopted so as not to give too much work in one year.

(4) Thinnings will be carried out in areas bearing pole crops.

RAM NATH, P.F.S.

MODIFICATIONS OF VON MANTEL'S FORMULA.

In the fitness of things Mr. Howard, the Imperial Silviculturist, led the way in the quest of a suitable formula for the determination of the possibility of our forests of which the rate of growth is so little known. Following in his wake Mr. Smythies, the Silviculturist of the United Provinces, has arrived at a general formula to give the yield in timber only. He has found that his new formula gives a higher result than Mr. Howard's, although the reverse should be the case. He has not however tried to account for this anomaly. But Mr. Howard had said in his article that his was a conservative estimate, although fairly liberal compared to others of earlier date. Perhaps, Mr. Smythies wants to put it that the estimate is too conservative. It is, however, a matter for consideration whether or not we should tap our forests to their utmost capacity, especially in Bengal where restocking is so difficult and slow. In any case, we might keep our formulæ tip-top, if possible, so that any deduction from the real yield may be made with knowledge according as the special nature of a case demands.

A general formula is also the logical conclusion of the line of reasoning as adopted by Mr. Howard. This formula, when worked out, will appear to be more comprehensive than Von Mantel's formula and, if found correct, might entirely supersede it; but this seems rather unlikely; yet, such a formula with certain limitations may be found handy for our purpose. I propose, therefore, to work it out below. In order to clearly define the limits of its utility, an analysis of Mr. Howard's arguments will probably best serve the purpose, as it is the direct result of his line of thought. Moreover, the discussion that I am about to enter upon may probably help us to get an insight into the formula and settle uncertain points.

Von Mantel, in arriving at his formula, $Y = \frac{v'}{\frac{r}{2}}$, assumed that y (real yield) is to v (real volume) as y (normal yield) is to y (normal volume); but Mr. Howard substituted the volume of

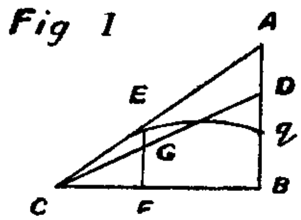
half the rotation age and over for each of v and V, and eventually got the formula $Y = \frac{v'}{\frac{3}{8}r}$ (where $v' = vol.$ of $\frac{1}{2}$ rotation age and over).

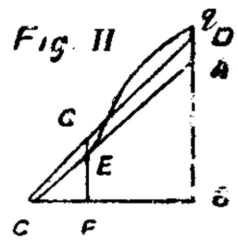
Mr. Howard claims that his formula is only an inevitable corollary of Von Mantel's proposition. But he must have made some other assumption and omitted to state it as being too obvious to be mentioned or being probably, common to other similar formulæ. In the absence of a clear statement the reasoning appears to be this that when a certain relation is recognised to exist between two things, each as a whole, the same should also be found between their parts. He has thus seemingly ignored the important proviso that this is only true when the relation between any two parts of the one is the same as that between the corresponding parts of the other, *e.g.*, a regular cylindrical vessel and an ordinary bucket may hold equal volumes of water when full, but if they are emptied down to half their height the volume of water in each will evidently be no longer equal. His formula thus appears to be true for normal forests of different kinds of quality of locality, or for an abnormal forest where the degree of abnormality is the same throughout in all age classes, and for other forests only approximately so.

Due, probably, to this omission of a statement of all conditions, there arose in his article an uncertainty as to the girth limit down to which enumeration should proceed. He seems to favour the view that enumeration may not be carried below the limit of abnormality ; but no reasons have been adduced. Certainly, the yield will not be fixed by an enumeration of a few abnormal upper age classes only, while it is possible to go further down. His estimate will therefore be conservative when there is a deficiency, but too liberal when an excess of growing stock marks the abnormality. His formula is evidently not meant to be applied to a forest where abnormality occurs in the lower age classes also.

A graphic representation of normal and abnormal forests will probably show up the objections more clearly. As usual the normal growing stock may be represented by the Δ ABC of

which AB, the altitude is the normal yield, but an abnormal forest is not always so conformable. It is, however, always possible to find a $\triangle$ with rotation as its base to represent the total volume whatever that volume may be.





Let CEqB be the real growing stock and let DBC be the required Δ. Then, only the total volume of the real growing stock will be represented by the Δ, it being obtained by moving a portion of the lower girth classes to the place of the higher where the higher girth classes are in deficiency and *vice versâ*, but the volume of any particular girth class will seldom be equal to the corresponding segment of the Δ.

Now Mr. Howard's relation is strictly correct only for this Δ which is the "equivalent growing stock" and not for the figure bounded by the irregular curve which is the real growing stock. But no such objection can be brought to bear against Von Mantel's formula, as it takes into consideration the entire volume of the forest. It is also apparent that the volume of the abnormal portion of the growing stock, *i.e.* qBFE, can have no fixed relation to the whole volume. It will be seen that as the line EF is shifted closer and closer to C the difference in area between qBFE and DBFG will be less and less or in other words, if enumeration is carried to a lower and lower girth class the objections noted above will have less and less effect, and for complete enumeration will vanish. Thus the aim should always be towards complete enumeration irrespective of the limit of abnormality.

Mr. Smythies makes another assumption that the smallest girth classes which could not be enumerated should be normally present in order that after $\frac{r}{a}$ years or $r-x$ years, as the case may be, the yield may not fall off, but the above considerations will

show that this will not happen so long as the crop left out, is not more abnormal than that enumerated.

We, thus, arrive at the following conclusions :—

(1) that Mr. Howard's relation is true for the "equivalent growing stock" and approximately so for the real growing stock ;

(2) that if a greater proportion of the growing stock is taken into consideration objections to Mr. Howard's relation diminish ;

(3) that enumeration should therefore be done down to as low a girth class as it is possible in practice to do ;

(4) that the portion of the growing stock thus left out will be assumed to be not more abnormal than the part enumerated.

The last two are the conditions which should limit the use of the general formula at which Mr. Howard aims. We shall now proceed to build it.

For the same figure let the area of $\triangle$ ABC = V (normal volume).

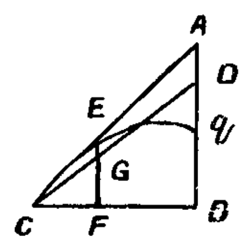


fig. ABFE = V′

$\triangle$ DBC = v (real volume)

fig. DBFG = v'

fig. qBFE = Ve (vol. of enumerated girth classes)

CB = r (rotation)

i = mean annual increment.

also let $\frac{CF}{CB} = m$ so that $CF = mr$

$EF = mri$

$AB = ri = Y$ (normal yield)

$DB = y$ (real yield)

Now, $V' = V - EFC$

$$= \frac{r^2 i}{2} - \frac{m^2 r^2 i}{2} = \frac{r^2 i}{2}(1 - m^2) = V(1 - m^2)$$

Similarly $v' = v\,(1 - m_2)$

From the figure $\frac{DB}{AB} = \frac{v}{V}$

$$i.e., \frac{y}{Y} = \frac{v}{V} \text{ (Von Mantel's assumption)}$$

$$= \frac{v(1-m^2)}{V(1-m^2)}$$

$$= \frac{v'}{V(1-m^2)}$$

$$= \frac{v'}{(1-m^2)\frac{r^2 i}{2}}$$

$$\text{or,} \quad \frac{y}{ri} = \frac{v'}{(1-m^2)\frac{r^2 i}{2}}$$

$$\text{or,} \quad y = \frac{v'}{(1-m^2)\frac{r}{2}}$$

When 'm' is small v' and v_e will differ by a very small amount and may, therefore, be taken to be equal, with allowable error.

Thus we arrive at the general formula

$$y = \frac{v_e}{(1-m^2)\frac{r}{2}}$$

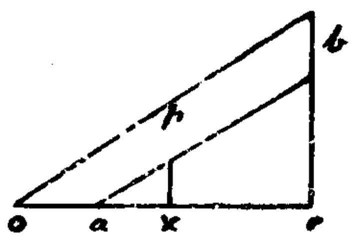
where 'm' is the ratio of the age of the lowest girth class enumerated and the rotation.

The scope of this formula without limitations is wide enough to include the two formulæ of Von Mantel and Mr. Howard, as by substituting O and $\frac{1}{2}$, successively, for m, both can be obtained.

Mr. Smythies' idea of finding the yield in timber only, appears to be more practical. Examined in the above light; the aforesaid objections, too, have lost much of their weight against his formula, as he carries his enumeration to a much lower girth class; but they still apply. The real growing stock is not what he calls timber trees but includes lower girth classes as well which he neglects. For this reason he has to presuppose the existence of a normal crop below age x although it is not necessary to concede as much. But when he says that his formula is approximately true for all values of x he probably assumes too much, for, an increase in the value of x brings his formula more and more within the pale of the said objections.

His formula is however open to one other objection due to which his yield is higher than the real. The age of a tree which measures exactly 8″ diameter at breast height is taken to be zero, its volume ought, therefore, be also zero, but a piece below breast height down to the foot has evidently been measured.

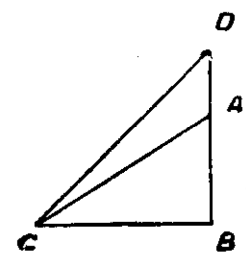
Thus he should get the figure $x\,p\,b\,r$ and not a Δ. His zero should be the age of a tree which measures 8″ diameter at the base, *i.e.*, in the figure it will lie at 'a' where $b\,p$ produced cuts $O\,r$. Thus in his formula, $y = \frac{2v}{r-x}$, x is less than what he



finds, so $r-x$ increases, therefore $\frac{2v}{r-x}$ diminishes. The decrease may be 10 per cent. or more on this account, depending on the difference in age of the two trees of diameter 8″ measured at breast height and at the foot respectively; it being remembered that the denominator is an important factor inasmuch as for every increase of one in it the numerator should be increased by $\frac{2v}{r-x}$ in order that the quotient or y may remain unaltered, It is difficult in practice to measure the volume represented by $a\,p\,x$ but the age 'a' can be easily found by felling and counting rings of a few trees of 8″ diameter measured at the base. Having found 'a' the error of not measuring the volume $a\,p\,x$ can be nearly eliminated by introducing m. Thus the formula reduces itself to $y = \frac{v}{(1-m^2)\frac{r-a}{2}}$ where $m = \frac{x-a}{r-a}$.

There may be a further objection in the way in which the collected data are made use of. For the North Kheri and the Thano forests the exploitable diameter corresponding to the rotation of 90 years is 18″ but trees up to 24″ diameter have been included in the calculation of 'v.' This too is a factor

increasing the yield. We will assume that trees over 18" diameter are over mature and no appreciable increment is put on by them year after year. Then let the Δ ABC represent the normal growing stock up to 90 years of age (rotation) and the



Δ DBC represent the volume of the forest including the over-mature stuff; then the Δ DBC will be equal to the volume of the over-mature stuff only. Under the circumstances the yield is usually taken to be DB, of which AB is replenished every year, whereas DA is not, or, only to a small extent. At this rate we will have removed all over-mature stuff in half the rotation years or thereabouts; then there will be a sudden fall in the yield. The Working Plan will probably be revised every 5 or 10 years and the yield readjusted but with every revision we will only be reducing the yield. It may probably be better if the volume of the over-mature stuff is separately calculated and distributed equally over the whole rotation, cutting in practice more from the over-mature stuff than from what is just ready. By so doing, we will be keeping something in hand, which is just over-age, and in any exceptional year the yield may be increased without deteriorating the forest. Normally there is no danger of having to reduce the yield at any time.

S. K. D.

POLYPORUS GILVUS (SCHW) FR. & PAT. A SUSPECTED ROOT PARASITE OF *SHISHAM (DALBERGIA SISSOO)*.

Last year during the rainy season an unusually large mortality of *shisham* was observed in Dehra Dun. Tea gardens and road sides on which *shisham* is grown as a shade tree and out of the way places where it is found in wild state all showed a large

proportion of deaths. Trees of all ages were attacked and killed.

The first tree, however, which attracted attention died in Chandbagh after showing the symptoms produced by *Ganoderma lucidum (Fomes lucidus)* and it was consequently assumed that this fungus was the cause since it is usually believed to be responsible for killing *shisham* trees in Dehra Dun, Changa Manga and various other places. But a little later and as a matter of fact quite against expectations this tree developed sporophores of an entirely different fungus and then it was thought advisable to examine other trees which have met with similar deaths outside Chandbagh to see what kind of sporophores they produce, as it is only through such observations that an idea of the possible causative agent of the disease can be formed. With this end in view a large number of trees, dead and dying, were carefully examined in all localities wherever *shisham* was seen dying. *Polyporus gilvus* fructified profusely on almost every one of them but *G. lucidum* was so rare, that except once in the Kaolagarh Tea Estate where a small sporophore of it had developed at the base of an apparently healthy tree it was not found on *shisham*. An instance in which a fructification of *G. applanatum* was found on exactly the same kind of rot as is usually associated with *P. gilvus*, was noticed on the Saharanpur Road; but this was, in all probabilty a saprophyte having grown on previously rotted wood.

It has been stated that *Ganoderma lucidum* is the cause of the death of *shisham* trees in Dehra Dun and the following statements in this connection are interesting :—

Mr. R. N. Parker (Forest Flora of the Punjab, 1918, p. 167).

"As serious fungus disease has caused much damage to *shisham* of recent years in Changa Manga. It is caused by *Fomes lucidus* (Leys) Fr. which attacks the roots of living trees and speedily causes their death. Large trees, coppice shoots and seedlings are attacked indiscriminately. The same disease is apparently killing *shisham* shade trees round Dehra Dun."

Mr. R. S. Troup (Silviculture of Indian Trees, 1921, vol. I, p. 299).

"A much more dangerous fungus is *Fomes lucidus* (Leys) Fr. which is the cause of much mortality among *shisham* trees in plantations and elsewhere; it is particularly prevalent in Changa Manga Plantations in the Punjab, where it has spread rapidly within recent years and killed out large numbers of trees of all sizes as well as coppice shoots and root suckers. The same fungus is very prevalent in tea gardens near Dehra Dun and is probably the cause of mysterious deaths noticed among *shisham* trees in various other localities."

Recent observations made in Dehra Dun do not seem to support these statements in so far as the Dehra *shisham* deaths are concerned. They doubtless hold good for Changa Manga and other places where no other fungus body has been observed except *Ganoderma lucidum*.

It should also be noted that in the Kaolagarh tea garden of which a mention has been made above *shisham* grows side by side with *Albizzia procera* which is highly susceptible to *Ganoderma lucidum*. In fact a large number of these *Albizzias* are definitely known to be attacked, and as a result typical sporophores arise every year on dead or dying trees till they are cut and removed yet *shisham* appears to have entirely escaped infection. It is only rarely on *shisham* that a sporophore may be found perhaps as an accidental growth. On the other hand, the invariable presence of *Polyporus gilvus* on nearly all diseased trees, dying or dead, constitutes a strong *primâ facie* case against it as being the real cause of the deaths.

The earliest signs of ill-health visible externally are either "stag head" or the partial or entire yellowness of the crown which strongly contrast with neighbouring healthy trees. Sometimes, prior to the development of any symptoms of disease the fungus directly gives rise to sporophores and is thus easily detected. It apparently forms localised patches under such circumstances, grows and fructifies without interfering much with the normal circulation of sap and without consequently creating unhealthy conditions at an early stage. Again, it may entirely fail to produce reproductive organs even long after the death of the trees.

This, as far as our present knowledge goes, happens only with those trees which are attacked or show signs of illness late in the season when the humidity is much reduced and the dry weather which follows the rains in Dehra Dun checks the growth of the fungus but apparently accelerates the death of already weakened trees.

Polyporus gilvus is here apparently recorded for the first time on this host in India. It seems to attack only the cortex and the sapwood and brings about a marked change in them. Heartwood is not touched at all. The fructifications usually appear above ground level as small yellow soft irregular cushionlike outgrowths attacked by a broad base which eventually expand and attain their normal shape and size. Infected wood assumes a dark brown colour which has a close resemblance to that of the heartwood. Later, as the decay advances the brown colour disappears and light buff spongy rot takes its place and emits a characteristic mushroom smell. This is the final stage.

The general symptoms described above more or less agree with those caused by *Ganoderma lucidum*, but we are not in a position, at present to say definitely what part it plays in causing the disease. Inoculations experiments are in progress in Dehra Dun and it is hoped that the parasitic nature of both fungi will be determined before long.

The writer's best thanks are due to Mr. R. N. Parker, Forest Botanist, for going through the manuscript and verifying certain observations recorded in this paper and to the Director, Royal Botanic Gardens, Kew, for determining specimens of *Polyporus gilvus*.

A. HAFIZ KHAN,
Assistant to Forest Botanist.

REVIEWS AND EXTRACTS.

LUMBER.

ITS MANUFACTURE AND DISTRIBUTION.

BY RALPH C. BRYANT.

Published by Messrs. Chapman and Hall, Ltd., London.

Price 23 *shillings.*

It is a great pleasure to be asked to review the above. Amongst the numerous acquaintances made during my visit to America in 1918, Mr. Bryant's name stands out as that of one of those with whom I came into such close touch that we became personal friends.

Mr. Bryant graduated at Yale University and was for some years in the U. S. Forest Service, but he subsequently went to Yale as Professor of Lumbering and has been there for many years, except for a break caused by his taking up special duty for the American Government during the War. It is worthy of note that the Professorship of Lumbering has cost the University next to nothing as it was originally instituted and is still maintained by contributions from firms and private individuals interested in the timber trade. If hard-hearted business men in the States think it worth while to pay for the training at an University of men who subsequently enter their employment in forest or mill what about India and Burma? Hitherto special University training has been limited to men who become Government officials in the Forest Department, and even that training has really been in little else but Silviculture. Forest Engineering has not received its proper share of attention, and is not likely to, until something similar to the American Chairs of Lumbering forms part of the University training at home. We want men with as keen and as instructed an outlook with regard to the marketing of timber as they have at present with regard to the growing of it. The recruitment of a number of Forest Engineers some two years ago was only one small step in the right direction. The problem as a whole still remains to be tackled.

But even if Government does give its men adequate training in Forest Engineering the outlook will only be a poor one

until timber firms in the East realise the value of putting their recruits through some such course of special training before engaging in practical work. I can well imagine that such a remark made to the present generation of people interested in timber would cause a smile of amused incredulity. The fact however remains that such training is now-a-days recognised as worth paying for in Canada and the States, and there can be no question that it would certainly tend towards better lumbering and more sympathetic relations between timber staff and Forest officials in the East if each had some special training in the work of the other, and if they had in common the *esprit de corps* that such training together would give them.

My own personal regret is that Bryant's book was not published earlier. If it had been available in 1918 it would have saved me an immense amount of trouble. During my tour in America I enquired in vain for any good book on saw-milling and manufacture. I had to rely on illustrations in catalogues and what I myself gathered from visits to mills and factories and from talks with staffs. It is indeed a source of gratification to me to find on going through Bryant's book that there is so little which stands in need of correction in my own book on my visit to America.

The book is certainly a mine of information on pretty well all aspects of the trade from an American standpoint. It may well be commended to the notice of everybody concerned with timber in the East, although fully one-third may not interest them much, and one is apt to be put off by the constant need for mental calculation in turning board feet into cubic feet and for frequent reference to the index for the meaning of trade terms.

All the same, the book should certainly not be lightly put aside by the practical man, for one very important reason. The mill design described in it is the direct outcome of what is day by day becoming a matter of greater and greater importance, even in the East, namely, the expensiveness of labour. In America, labour has all along been expensive and so, in saw-milling as in other industries, efforts have been untiring in the

invention of labour saving devices. The modern American saw-mill is the direct result of these efforts. In India, when coolies could be got at two annas to four annas a day it did not matter much how many were employed but now that they are hard to get at a rupee a day the total of the wages bill becomes a very serious item. It may well therefore quicken the interest of the owner of a mill of the ordinary type to learn that in a mill of the type described in this book the same amount of output could be obtained with less than one-fifth of the number of hands. Some of the men required may individually be more expensive than any of the men in existing mills, but it is believed that the total wages bill would be decidedly smaller.

The book is divided into three Parts dealing with (i) Structural details of the Mill and its accessories, (ii) Lumber Manufacture and (iii) Marketing respectively.

The summary of milling and manufacture given in the last four pages of the Introduction is very good and students are advised to refer back to it from time to time as they progress through the 170 pages of Part I. There is such a mass of detail in the latter that one is apt to lose one's way.

An important point to be remembered by readers of the book is that it is written primarily as a text-book for students. Pretty well all appliances on the market are mentioned but with little or no attempt to show preference for one make rather than for another. Moreover, the illustrations themselves are very largely diagrammatic and actual photographs of machines are so small that the special features of patents are hardly recognisable. In this connection it is to be remembered that patent rights in saw-mill machinery are chiefly in respect of details of parts of the equipment. For example, no one firm holds exclusive patent rights in log carriages. They only do so in respect of details of parts of the same. It is also to be remembered that owing to the author's official position as occupying a Chair of Lumbering maintained by an association of people engaged in the trade it would have been out of place for him to have done anything in the way of direct advertisement of the machines made by a particular firm. For the above reasons the practical man must

not expect to find everything in the book. With regard to any one stage of conversion, reference to the book will tell him what sorts of alternative machines and appliances are in vogue, but it will not give him sufficient detail to enable him to form an opinion as to which particular one is best for his own purpose, or as to where it can be obtained from. Here it may be remarked that enquirers in India and Burma can obtain a good deal of information on this head from the Central Institute, Dehra Dun, where a Bureau of Information with regard to Logging, Milling and Wood Working Machinery has been started. After perusal of catalogues of well-known firms which can be obtained there an intending purchaser can form some idea where to go for what he wants.

It is rather a pity that the author has not included a series of plants to scale and lists of machines with sizes for mills of different capacities, ranging from a mill with a daily output of say 100 tons down to a portable outfit capable of yielding say 5 to 10 tons. When referring to the book it would interest a practical man to be able mentally to compare his own mill or one he knows all about with an American type design of the same capacity.

One of the chief points to be noticed with regard to saw-mill practice in Canada and the United States is that it is so uniform throughout the Continent. After going through one fair-sized mill you have the key to all the mills because they are all of one general design, differences being merely in details. The next point to emphasise is the desirability of getting over the prejudice likely to be engendered by the fact that this general design or frame-work is so different to that usually found in the United Kingdom. Students in India and Burma need not run away with the idea that British milling practice is necessarily the best for tropical timbers because it is almost universally followed in both countries. There are numerous examples of American type saw-mills in The Philippines, The Straits Settlements and in Borneo. A British firm which has been in the trade in Burma for many years, is, as a matter of fact, now striking a new line by setting up a big Canadian Band Mill to deal with an extension of its business.

I do not, however, wish it to be inferred that American mil design is so good that it can be imported wholesale into the East without first of all giving careful consideration to the very great differences between the conditions under which mills have to work in the East as compared with America. Extreme variations in the hardness of tropical timbers, the absence of any general standard of length, and the multiplicity of sizes of scantling usually called for may well necessitate changes in design. But I am rather wandering from the point here, as the present article is intended to be a review of Bryant's book rather than a critical analysis of the relative merits of British and American practice, a matter which might well form the subject of a separate article.

Conditions in the East are so different to what they are in America that a good deal of Parts II and III of the book is of little interest to us. But Chapter IX (15 pages) devoted to a discussion of the various methods of breaking down logs and Chapter X (45 pages) on the Seasoning of Lumber should certainly not be omitted. Chapter XII (12 pages) and Chapter XVI (18 pages) on the Grading and Inspection of sawn timber would well repay careful reading, although they may not be so applicable to present-day conditions in the trade as they may be in the future, when the trade has become more standardised. Much the same remark applies to Chapter XVII (17 pages) on Transportation. Here it may be remarked that one striking difference between the East and America is that in the latter there are such strong combinations or associations of people interested in timber, whereas in the former every firm fights more or less for itself and combination can hardly be said to exist at all. The result is that Railways and Shipping Companies seem to have had it all their own way hitherto with regard to freights and loading and shipping regulations. And here I might perhaps venture to observe that timbermen in Burma may be inclined to think that much the same remark might be applied to the Forest Department. I cannot help but think that if people interested in the timber trade were to follow the lead of the trade in America and in Europe by combining into associations, conditions for the trade generally

might be improved. This would be possible to an even greater extent if there were more unofficial exchange of ideas between Forest Officials and the public.

Chapter XVIII is devoted to the American market and Chapter XIX to the foreign markets for American lumber. I have not the time to make a careful study of Mr. Bryant's remarks on these heads. Perhaps someone else may be lead to take the matter up, and to make similar enquiries with regard to our own trade. I am sure it would be of immense value if a critical *analysis of the home and export trade in India and Burma timbers* were made available. A sentence which has caught my eye is of particular interest ; on page 395 it is stated that only a very small volume of hardwoods are shipped across the Rocky Mountains to the Pacific Coast "because high transportation costs do not often permit shippers to compete successfully with Asiatic hardwoods shipped from Japan." I believe that a market is to be found for Burma hardwoods on the Pacific Coast and that all the first requirement for a successful start is to make a close study of the trade in Western America and then for millers to make an effort to supply the sizes required and not to force people to take something else.

There are several very useful tabular statements at the end of the book, as for example, Average Weights of Wood per c. ft. (pages 483 and 494), Standard estimated weights of Lumber (page 495), Average shrinkage in seasoning (page 503), Band Saw-mill data (page 510), Circular Saw speeds and number o teeth (page 513).

In conclusion, I hope I have written enough to show that the book ought to be of interest both to the Forester and Engineer in Government service and to the timber trade generally. Anyone who is interested in the subject could find a very useful outlet for his energies in making an exhaustive study of milling and marketing conditions in the East, either as a separate publication or as part of a book on milling and manufacture, especially written for people accustomed to British practice and nomenclature. The value of such a book would naturally be

enhanced if it contained a critical analysis of milling practice in Europe and in America.

F. A. L.

READY RECKONER OF TIMBER MEASUREMENTS.

BY S. A. NADKARNI OF KARWAR, NORTH KANARA, BOMBAY.

Price Rs. 2.

The following points are noticed :—

(1) The heading of the Tables gives Quarter-Girths. Whereas it would be much more convenient, if the actual girth were written on the heading. This would obviate the measuring office having to divide his figures by 4, in order to see on which page the figures he requires are to be found. For exam ple on page 23 the heading should read—

TABLES.

Girth 15″ Coeff : 09766

(2) The classification of timber at the end of the introduction appears to be a local one, referring to Bombay only.

(3) In the introduction on page (*ii*), it is stated that the procedure in the case of logs improperly trimmed should be to take the mean of the end girths, and with a log "like a cone" to take the mean of the two end and the mid-girths.

The whole of this page is rather obscure and it is not clear that there is any difference between a "log thicker at one end and thinner at the other" and the "log like a cone." The diagrams in both cases show that a truncated cone is meant.

What formula should be used depends on the accuracy required, *i.e.*, whether we use (1) the mid-girth, (2) the mean of the end girths or (3) the prismoidal formula.

It would appear that the author of the Tables wishes us to use (3) with the log like a cone ; but has not quoted it correctly

If g_1, g_m and g_2 are the girths at the big end, mid-point and small end l is the length of the log the formulæ are—

$$(1)\ \text{Vol} = \left(\frac{g_m}{4}\right)^2 \times 1$$

$$(2)\ \text{Vol} = \left\{\frac{\tfrac{1}{2}(g + g}{4}\right\}^2 \times$$

$$(3)\ \text{Vol} = \frac{l}{6} \times \left[\left(\frac{g_1}{4}\right)^2 + 4\left(\frac{g_m}{4}\right)^2 + \left(\frac{g_2}{4}\right)^2\right]$$

$$\text{not } V = \left\{\frac{\tfrac{1}{3}(g_1 + g_m + g_2}{4}\right\}^2 \times l$$

The quarter-girth method is an approximation only and gives, even with perfectly regular and smooth logs, the volume within $21\frac{1}{2}$ per cent. only. This being so and bearing in mind the irregularities in logs, it is of little use to use an "accurate" formula with "inaccurate" data. Ordinarily the practice of using mid-girth with quarter-girth calculations is sufficiently accurate.

Any question of the formula to be employed might with advantage be omitted from the introduction and left to the discretion of the officer, using the Tables.

The Tables have apparently been worked out for mid-girth and as such are useful, and should prove of practical value to foresters, timber-contractors and others dealing with timber.

C. E. S.

ASSAM FOREST CONCESSION.

"SIMUL CULTIVATION."

Jungle Reserve Leased to Planter.

This departure from the general rule of the Forest Department of Assam will be watched with interest. It is in the nature of an experiment but if it proves successful from the point of view of the Department it will no doubt be carried on. Certain jungle reserves have been leased for twenty years to a South Sylhet planter on condition that he plants jack-fruit trees and *simul* cotton trees 30 ft. by 30 ft. and 20 ft. by 20 ft. respectively. He may plant whatever he likes between as long as such does not interfere with the growth of the trees mentioned. For the period

mentioned he may harvest and dispose of the products of the jack trees and *simul*, and pending any other arrangement that may be entered into with the lessee on the expiry of the lease in 1944, the trees become the property of Government.

As 20 years will not see the trees at full maturity for cutting the Government most likely will not kill the goose that lays the golden eggs but will probably charge a rental according to the calculated yield. For the 20 years the rent will be twelve annas per acre. It is stipulated that the planted trees be carefully looked after and protected. Nurseries must hold plants for filling in vacancies and the plantation will, at all times, be subject to periodical inspections by Government officers.

Of course it is as much to the interest of the lessee to keep the trees going strong as it is to that of the lessor, if the lessee keeps the jack trees and *simul* cultivated once a year, with the aid of fertilisers, they will give a crop in their fourth year worth Re. 1 per tree on the average, and so on progressively. Silk cotton has risen in price 300 per cent. during the last 10 years and according to those in the trade is likely to go further up still. The fact that the wood of the jack has more than doubled in price during recent years has no interest for the lessee as the wood is not at his disposal. But this rise in value has had the effect of a very large number of our best trees being cut down to the serious lessening of the number of fruits on the market and what has been pronounced as an alarming reduction in the quality of an important food of the people.

During the last three years this fruit is said to have increased in price by upwards of 75 per cent. Boats come regularly up the rivers specially for jack fruits and bananas and it often happens that the whole crops of villages are hypothecated by outside traders months before the fruits are ready for harvesting.

There is no lack of remunerative markets for the produce of the jack and *simul*.

CATCH CROPS.

The lessee may plant as catch crops ground-nuts which can always be depended upon for a clear profit of Rs. 150 to Rs. 200

per acre. This latter crop is a one season one. If seeds are planted in May they are ready for harvesting in November and the demand for this product is practically unlimited. The arrangement has been pronounced by competent authorities as a first-class proposition for both lessor and the lessee. The advantages of the latter are as already stated and the advantage on the Assam Government side is that at the end of the lease they are in possession of a valuable property which has cost them nothing. Of course if the reserved lands were growing jack and timber trees the arrangement could not have been entered into but as they are situated in a populous district in close touch with a ghat on one of our main rivers, the class timbers have all disappeared year s ago.

Marching on the leased land the lessee has a block of land independent of Government control where he intends growing West Indian limes, dwarf cocoanut, West African oil palm and betel-nut palm. Some of these will be planted, not as certainties, but on account of their vast possibilities, will merely be planted amongst *simul* cotton trees which will act as stand-byes in case the palms do not take kindly to the Surma Valley. We already know the lime will grow and produce abundantly in our tea districts and, in the form of citrate, citric acid or merely concentrated juice, at the present time the demand exceeds the supply.

Besides the prospects of the "new move," as it has been called, being bright to the point of absolute certainty it will prove of great interest to planters of the Surma Valley. If the King coconut or the West Indian oil palm prove suitable planting subjects they will have strings to their bow which hitherto have been strangely conspicuous by their absence.—[*The Statesman.*]

HIMALAYAN ANTHROPOIDS.

"THE ABOMINABLE SNOWMAN."

BY E. O. SHEBBEARE,

Deputy Conservator of Forests.

An article under the above heading by my friend Mr. Lindgren in the *Darjeeling Advertiser* of 4th April brings up once more the old question of the *Jangli-admi.*

Rumours of the existence of an anthropoid ape of considerable size, at high elevations in the Himalayas, keep cropping up from time to time, and I have had the curiosity to file such reports as have come my way among my natural history notes, though I am not at all convinced that they should not more properly be classed as folk-lore.

The name of the animal varies with the vernacular of the observer, *jangli-admi*, *banmanshi* and *sogpa* being respectively the Hindustani, Nepali and Tibetan for "wild man"; and when the Mount Everest reconnaissance party came upon what the coolies declared to be his footprints in the snow on the Lhakpa-La (22,350 ft.) he received a new Tibetan name, *metoh-kang-mi* which was rendered as the "abominable snowman."

As far as I know, the first reference to anything of this sort occurs in Hooker's *Himalayan Journal* but unfortunately I have not got the book by me and I cannot remember whether there is anything in Hooker's account to show that he was not referring to the Nepal langur which ascends to high elevations.

The next reference in point of time would be the account of the occurrence in the recent issue of the *Darjeeling Advertiser*. The description of the animal shot here by Mr. Petry in 1899 is rather vague, and might almost apply to a savage, old and solitary Himalayan monkey *(Macaca assamica)*. At any rate its attacks appear to have been limited to biting women and children, a very mild performance for a beast as formidable as other accounts of the *jangli-admi* suggest.

Mr. Gent did not see the animal himself but reported the presence of a large monkey or ape below Phalut in December 1914 in a letter to Mr. Elwes which the latter read before the Zoological Society. I quote an extract from the proceedings of that society on the point :—

From the Proceedings of the Zoological Society of London, in 1915, published in June 1915.

Mr. H. J. Elwes, F.R.S., F.Z.S., read the following extract from a letter that he had received from Mr. J. R. P. Gent, Forest

Officer of the Darjeeling Division, on the possible existence of a large ape, unknown to science, in Sikkim :—

"I have discovered the existence of another animal but cannot make out what it is, a big monkey or ape perhaps—if there were any apes in India. It is a beast of very high elevations and only gets down to Phalut in the cold weather. It is covered with longish hair, face also hairy, the ordinary yellowish-brown colour of the Bengal monkey. Stands about 4 feet high and goes about on the ground chiefly, though I think it can also climb.

"The peculiar feature is that its tracks are about eighteen inches or two feet long and the toes point in the opposite direction to that in which the animal is moving. The breadth of the track is about 6 inches. I take it he walks on his knees and shins instead of on the sole of his foot. He is known as the *jangli-admi* or *sogpa*. One was worrying a lot of coolies working in the forest below Phalut in December, they were very frightened and would not go into work. I set off as soon as I could to try and bag the beast, but before I arrived the Forester had been letting off a gun and frightened it away, so I saw nothing. An old choukidar of Phalut told me he had frequently seen them in the snow there, and confirmed the description of the tracks.

"It is a thing that practically no Englishman has ever heard of, but all the natives in the higher villages know about it. All I can say is it is *not the Nepal Langur*, but I've impressed on people up there that I want information next time one is about.'

About 1917 or 1918 there were two reports of men said to have been killed by the *banmanshi* somewhere in the Kalimpong sub-division but I have no record of these.

In September 1918 there are two records, one by a villager of Paiengaon (Kalimpong sub-division) who reported that he met a "big monkey, just like a man" in the forest near Lava. The recipient of this report, a forester named Ashutosh Guha, went to the spot to verify the account and writes that he found the footprint of the animal like that of a man but 19 inches long and 7 inches broad.

The second report from the same neighbourhood at about the same time was that Mr. Pyne, then Sub-Divisional Officer at

Kalimpong, had heard the animal while stopping at the Pashiting forest bungalow. I wrote to Mr. Pyne and have his reply in which he says that he heard an unearthly noise in the forest close to the bungalow during the night of 15th September and that his servants in the morning assured him that this was the *banmanshi*. He describes the noise as being something between that of a pig and a shrill human voice lasting for about a minute with two short breaks.

The last record is that of the Mount Everest Reconnaissance Party in 1921 which reported that on the Lhakpa-La on 22nd September " We distinguished here and there fox tracks, but one mark, like that of a human foot, was most puzzling. The coolies assured us that it was the track of a wild hairy man, and that these were occasionaly to be found in the wildest and most inaccessible mountains." (*The Times*, October 22nd, 1921.) This announcement in the *Times* appears to have stated a good deal of correspondence in the Home papers of which I have no records and most of which I did not see. I only recollect hearing that a letter had appeared in the *Times* written by one who was formerly very well known in this district and in Sikkim, Mr. C. F. Simmonds (" Bushranger " Simmonds) in which he wrote that he believed the animal to be the red bear *(ursus isabellinus)* as he had heard one of the names, *jangli-admi* I think, applied to this animal. Mr. Simmonds has travelled a great deal in the Himalayas in out-of-the-way parts.

The general conclusion from the correspondence appears to have been to discredit the anthropoid ape theory and Colonel Howard Bury in writing up the 1921 Reconnaissance (page 141) attributes the footprints seen on Lhakpa-La to a large " loping " grey wolf which in the soft snow formed double tracks rather like those of a barefooted man. He refers to the *Metoh-kang-mi* as the " bogeyman " of Tibet and tells us that the children are warned that, should he chase them, they must run down-hill so that the long hair, falling over his eyes, will prevent his seeing them. A similar superstition is current in this district where it is said that a male *sogpa* can easily overtake a man but that, by running down-hill, one can escape from the female as her breasts trip her

up; going up-hill she throws them over her shoulders. This story seems to conflict with the usual account of the beast running on its hind legs. The reference to the tracks pointing in the wrong direction in Mr. Gent's account seems to have a family likeness to the description of some Indian "spooks" who have their feet turned backwards on their ankles. It may be remarked here that the existence of such fairy-stories as the above does not once for all dispose of the *sogpa's* claims to reality, for legends quite as wild have attached themselves to several real animals, the elephant, the wild-dog and the cobra to mention no more.

Taken all round, the evidence for the existence of the *sogpa* does not seem to be very convincing. No competent observer appears ever to have seen an unmistakeable anthropoid ape in the Himalayas; no tracks have ever been photographed or sketched, nor have any been seen by reliable observers that could not be explained away, and the so-called *sogpa* hair left on the trees against which he has rubbed himself and is sometimes sold by Tibetan charm sellers, is almost certainly that of the red bear although I have never obtained any for comparison. On the other hand, there are more things in heaven and earth than are known in our philosophy, and there seems to be nothing to prevent even so large an animal escaping detection in so little-known a habitat as that ascribed to him, provided that he is sufficiently rare. Arguments against his existence based on absence of food-supply do not seem particularly convincing, and those based on his choice of habitat (all other anthropoid ape being tropical) even less so; nobody claims a closer relationship for him with the gorilla, chimpanzee and ourang-outang than exists say between the sloth-bear of the hottest parts of India and the polar bear of Arctic regions.

Without advancing it as an argument in favour of the existence of the *sogpa* I will conclude with a cutting which I find among my notes, and which seems to have a certain bearing on the point though I have failed to note where I got it from.

"John Barrell suggested that primitive men may have originated during the uplift of the Himalayas at the end of the Miocene and beginning of the Pliocene. As the land rose the

temperature dropped and some apes which had hitherto lived in warm forests would be trapped to the north of the raised area. As comparatively dry plains would there take the place of forests, and as the apes could no longer emigrate southwards those that survived must have become adapted for living on the ground and acquired carnivorous instead of frugivorous habits."

[The reference to which Mr. Shebbeare alludes occurs on page 313 of Hooker's " Himalayan Journals " as follows : " On arriving (at Tallum and Tungu) I saw a troop of large monkeys gambolling in a wood of *Abies Brunoniana* : this surprised me as I was not prepared to find so tropical an animal associated with a vegetation typical of a boreal climate." In a foot-note he names the monkeys *Macacus Pelops ?* Hodgson. " This is a very different species from the tropical kind seen in Nepal."—Editor.]

[*The Darjeeling Advertiser.*]

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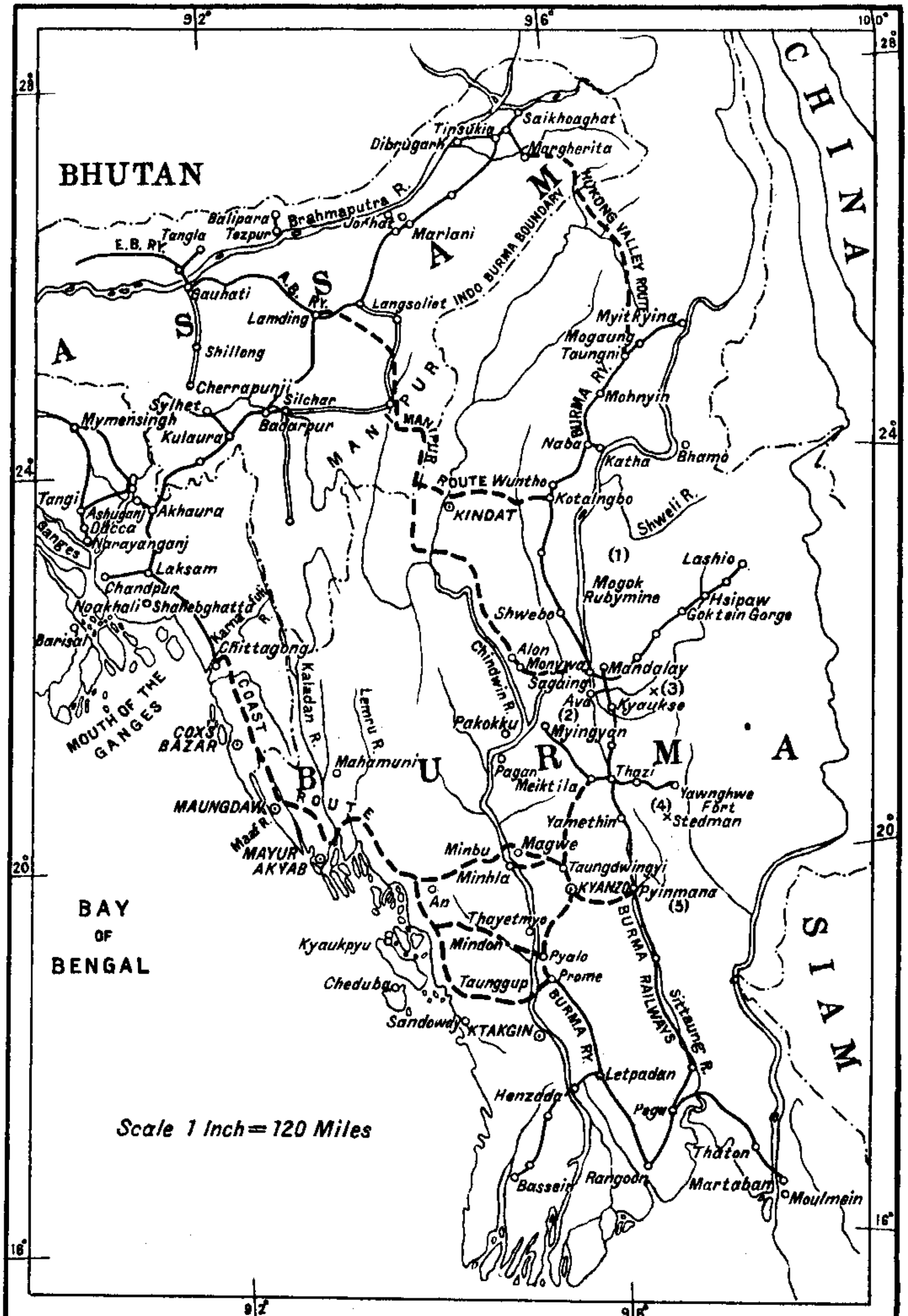
ASSAM TO BURMA ACROSS THE HILLS.

In connection with the linking of Burma and India by railway, three reconnaissance surveys were undertaken by the Government of India in 1896; one through Manipur in Assam another through the An Pass, *i. e.*, more or less along the Arakan Coast in Burma, and the third from the Dibru-Sadiya Railway terminus at Ledo across the Patkoi Range, through the Hukong Valley. This is called the Hukong Valley route. Mr. Way, then Engineer-in-chief reported that the Arakan Coast route was exceedingly difficult and expensive, while the Military Department also had the greatest objection to the route. In 1915, the Manipur route was definitely abandoned. During the field season of 1917-18, Mr. Stevenson, an Engineer of the Assam Bengal Railway, was deputed to find out whether it would be possible to avoid Mr. Way's alignment of the Patkoi section which involved a steep gradient of about 50 miles on either side of the Patkoi ridge, and a 5,000 ft. tunnel through it. Mr. Stevenson found that by going up the Namphuk Valley further east he could include a saddle called Sympana which would not only ease off the gradient, but reduce the tunnel to about 1,000 ft. only. In 1919, a preliminary survey of the Hukong Valley route was ordered, and in the beginning of 1920, a portion of the route between Assam and Loglai Valley was surveyed. In 1921, the survey was again resumed both on the Assam and Burma side, and Mr. Allum, the Engineer-in-chief, asked the Assam Government for a Forest Officer to report on the forests along the proposed railway line. I was luckily selected for the work, on

1

SKETCH-MAP SHOWING THE DIFFERENT INDO-BURMA RAILWAY RECONNAISSANCE SURVEY ROUTES.



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deputation, for which I am greatly indebted to Mr. Todd, then Conservator of Forests, Eastern Circle, Assam. The Geological Survey of India also sent Dr. Murray Stuart, Superintendent of the Geological Survey, to report on the geology of the country.

Our party consisted of Mr. F. W. Allum, Engineer-in-chief, Dr. Murray Stuart, Superintendent of the Geological Survey, and myself. We had with us a sub-assistant surgeon, 12 sepoys from the Assam Rifles, and about 200 Gurkha and Naga porters for carrying our kit and provisions. At first, we did not entrust the Nagas with our personal kit, as we were not sure they would not run away with them to their mountain homes. The Gurkhas, therefore, carried our personal kit and Nagas our provisions. It must be said to the credit of the Nagas that they proved absolutely trustworthy and when at Namyung Jup* we had to send back our military guard and Gurkha porters, the Nagas were employed to carry all our kit, except cash and opium chests.

At Namchik, 18 miles from Ledo the present terminus of the Dibru-Sadiya Railway, our base depôt was established. Besides we had three other ration dumps, at Nambong (mile 40), at Loglai Jup (mile 99), and at Namyung Jup (mile 117), to pick up rations on our march. Three signalling stations were cleared, one at Namchik, one on the Patkoi ridge and the third at Loglai Jup, and communications were kept up by some of the sepoys who were trained signallers. Ration dumps were filled in advance, and a military guard was sent at Loglai Jup and two Singpho headmen to Nambong and Namyung to look after the dumps till the party reached those places.

In the Lakhimpur Frontier Tract, there is a minor Singpho chief named Bisa Yong who has great influence over the Nagas in the Patkois. Two other headmen, Bisa Ladoi and Ningrengrong also have some influence. These men were sent for, and rates for the Naga coolies were settled. The Nagas took some time to finish up harvesting and storing their paddy and when they came down to our base depôt at Namchik, they were at first employed to carry rations to our advance ration dumps. Along

* Jup means the junction of two streams.

1. A Naga chief and companion. The chief is wearing a false beard of wild pig's bristles and the two tushes on his hat.

2. The effect of dynamiting a pool in Sadu-jup, Mytkyina frontier.

Photo-Mech. Dept., Thomason College, Roorkee.

3. Our camp in the forests, at Namyung-jup, Naga country

Photos by R. N. De. P.F.S.

4. A group of Naga maidens.

with the carriers, came some Naga chiefs and mates or *sardars*. A chief, Morum Lakhim by name, was with us till we reached Namyung Jup. The chief of Sagwan also sent his son to accompany the party. These chiefs were given free rations and 2 annas commission per head of coolie under him. The mates were paid Re. 1-4 per day, and grown up men and women were given Re. 1 daily. For young boys and girls, the rate was 12 annas. Photo 1 shows a Naga chief with his true Naga head gear and false beard!

Having completed these arrangements we started for our journey on the 23rd December, 1920. From Namchik, we followed the Namphuk river up to Nambong Jup and then turning to the right followed the Namkri stream. We reached the top of the Patkoi ridge on the 30th of December at an elevation of 4,100 ft., about one mile east of Way's Pass. Patkoi is the water-parting between Assam and Burma. The view of the surrounding country is magnificent; towards the south of the ridge, the waters of the Noongyong lake were glittering in the bright winter sun and on the north a beautiful panorama of innumerable hills dotted over with Naga *jhums** and villages Under the auspices of the Railway Survey, a party of surveyors were sent by the Assam Hydro-Electric Survey Department to ascertain the possibility of a hydro-electric scheme by putting a bund across the Noongyong river, the only outlet of the lake The Noongyong lake is about 2 miles long and one mile wide and very swampy along the edge. The Nagas were very much afraid to go near the lake, the shores of which they told us, were teeming with wild animals of all kinds. They believe that it is haunted by ghosts and goblins.

The forests up to the foot of Patkois are of the usual evergreen type found in these parts, *Mesua ferrea*, *Terminalia myriocarpa*, *Dipterocarpus pilosus*, *Shorea assamica* and *Quercus semiserrata*, being the common species. There are many *jhums* in this part of the country. The character of the forest altogether changes on the Patkois and a different flora is noticed, the chief species being *Quercus pachyphylla*, *Q. spicata*, *Q. Thom-*

* *Jhums* mean patches of shifting cultivation.

soni, *Castanopsis* spp., *Prunus* spp., *Ilex* spp., etc. Unlike the Himalayan oaks, Patkoi oaks have clear boles up to an average of 40'. The Nagas who inhabit those hills use them very largely for beams, rafters, etc., for their dwelling houses. Wild tea is found on the Patkoi in places, and I believe it is here that wild tea was first discovered. We halted on the Patkoi ridge for two days which were utilised in clearing a temporary signalling station and building up a ration dump. What with the chilly wind and occasional rain, life on the Patkois was not by any means comfortable, and I, for one, was right glad to get away from there.

From the southern slope of the Patkois we got into the tribal territory under the nominal control of the Political Officer of the Sadiya Frontier Tract.

The tribes in these parts are still confirmed head hunters and we noticed many heads of enemies, brought home as trophies, hung up in the verandahs of the houses, and we were not quite sure that, in case the whole tribe rose against us, our skulls would not add to the grandeur and beauty of some Naga parlour!

We reached Loglai Jup *viâ* Noongyong and Digum on the 8th of January, 1921. In the Loglai Jup, we came across the first Singpho village called Wakhet. Nagas who live on the Assam side of the Patkoi ridge are under the control of the Government, but those that live on the southern side do not pay taxes to anybody, but all of them recognise as nominal overlords the Singphos who live in the Hukong Valley. In this connection an amusing incident took place. While at Namyung, a well dressed young Singpho came to our camp and demanded commission from us for employing Nagas. The Engineer-in-chief flatly refused to entertain his claim. On seeing military guards and our large force, he thought that discretion was the better part of valour, and quietly left the camp. Loglai Jup is the junction of the Loglai and Turong rivers. Here we noticed a few Indian coolies who had been kidnapped by the Nagas from the tea gardens of Assam and sold to the Singphos, as slaves. Major Reich of the Survey of India who visited those parts in connec-

tion with some survey operations going on at the time, very kindly took the initiative and with the help of the Government rescued some of these men, both here and in the Hukong Valley, but others wanted to stay on willingly as they had taken Singpho wives and settled there.

From Loglai Jup onwards we followed the Turong river practically all along up to Sarrow, except for a short length.

The character of the forest is almost the same as that on the northern side of the Patkoi ridge. All along our route from Namchik to Sarrow, there are some excellent pools in the Namchik, Loglai and Turong rivers where plenty of fish mostly of *mahseer* variety are found. Our record catch was a 30 lb. *mahseer* caught by Dr. Murray Stuart in the Rikaw Jup with a rod and line. Nagas come down in large numbers in the valleys in cold weather and catch fish with nets, or by poisoning the pools. Some specially good pools are their preserves, which we spared from dynamiting at their request. Necessity knows no law. We had to feed our coolies with meat or fish to prevent scurvy among them, and as we could not get much *shikar* in the forest, we had to have recourse to dynamiting some of the pools after every few days. Our average was about 15 lbs. of fish per cartridge. The largest sized fish could scarcely be secured, because, though stunned, they would lie down at the bottom of the pool. This fish diet, I am glad to say, kept our Gurkha and Naga porters in good health and lively spirits, and in their attempts to catch fish, more than once, some of them had gone beyond their depths and would have found a watery grave but for our prompt rescue. Photograph 2 shows fish caught by dynamiting.

Very few wild animals were noticed in this section. We were told that Noonyong lake and its vicinity abounded in game but we could not go there for shooting. Green and imperial pigeons, and barking deer were the only creatures we shot. Our usual amusement after nightfall was playing a gramophone. Harry Lauder's comic songs, Tobermory and others, never failed to tickle our Naga and Singpho audience, and were a great relaxation for us also.

We reached Namyung Jup on the 16th of January and halted for 3 days to pick up our provisions and a new batch of Nagas who could relieve those who had come so far. We also sent back all our Gurkha porters from here, as they were required for Railway survey work on the Assam side of the Patkoi. From Namyung Jup onward the Turong river passes through a gorge which is one of the greatest obstacles to the passage of a railway. Photograph 3 shows the nature of the country and the forest.

Coal and petroleum have been reported to occur in the Naga country. Some Nagas told us that in the Shagwan Naga country they found a kind of boulder which weighed twice or three times more than an ordinary boulder of the same size. It is suspected that those boulders might contain platinum. The Gedu river brings down a mineral named Jadeite (Jade of commerce). It has got a beautiful green colour and is highly prized by the Chinese and the Burmans. Our Nepali porters somehow knew this fact, and everyone collected 10 to 15 seers of quartz and other pebbles that had a slight green colour. They were under the impression that they would rapidly become millionaires when they would sell these precious stones at Mogaung. But their disappointment could be better imagined than described when after carrying this extra weight for about a fortnight, they consulted Dr. Murray Stuart and were told that almost all of them were anything but Jade!

Before we left Namyung Jup, we made sure that we had sufficient rations to last up to Sarrow as there were no villages along our route within a reasonable distance. Nagas were also asked if they required any rice, and it was supplied to those who wanted them. After we had marched for about 8 days, they complained that their rice supply was getting exhausted and we were faced with a grave situation. We had no idea how far above Sarrow we would meet the Burma section of the Railway survey party and we took just sufficient provisions for us only to reach Sarrow as we had rather limited number of Nagas at Namyung. But we had to take the risk and issued provisions to the Nagas for two days only. Fortunately on the 27th, we met the Burma section under Mr. Jackson, Executive Engineer,

I give a short note collected in the evenings round camp fire, through my interpreter about the Nagas of the Patkoi Range. The Patkoi Nagas are divided into the Morang, Moshang Langsing, Sarthey, Shagwan and Tonglim clans. The various clans, speak different languages but most of them can understand the language of a neighbouring clan and some of them can speak Singpho. They are a Mongolian race and live in hou ses built on platforms supported by wooden posts. They usually use bamboo and palm leaves to thatch their houses but occasionally thatching grass is also used where available. They are quite a healthy people, but one would at once notice comparative scarcity of children in the villages. This, I believe, is due to the fact that the girls are married at rather a late age owing to the large amount of dowry a man has to pay before he can secure a bride. The usual dowry consists of rupees one hundred and forty in cash, one buffalo, one pig, one bull, a gong of copper, two barrels of wine and a gun. Ordinarily, the age of marriage of a girl is about 20 years, but it is sometimes as low as 14 or 15 years, if both the parties are of the same age. A youth wishing to marry, selects his own bride and wins her. Courting forms an essential part in a Naga marriage. Even if a man has got the requisite money, he may not be able to marry unless he can win a girl's affections. Every unmarried girl has a small bamboo reed flute called *pow* hung round her and carefully concealed under her clothes. This instrument has got a very low sound, and can only be heard if played near the ear. If a girl falls in love with a young man, she plays the flute near his ear, in some secluded place, usually near some watering place. Abduction of a girl before marriage to the house of the young man she loves, is not unusual but her parents must give consent to the marriage, or the girl will have to be returned. No marriage can take place without the consent of the parents of both the parties. It often happens that a young man has wooed and won a maiden, but is too poor to pay the price for her, in such cases marriage may take place provided the parents are willing, but the marriage debt has to be paid, either by giving a girl from the husband's family in marriage to a youth in the wife's family, or by instalments in cash and

kind. The girls most sought after, are those that know weaving, pounding rice and cooking.

The usual prohibited degrees of marriage are :—Step mother, brother's daughter, father's sister's daughter, uncle's daughter, mother's brother's daughter, step-mother's sister, aunts. Photograph 4 shows a group of unmarried Naga girls.

Nagas grow rice, poppy, gourd, sweet potato, yam and a few other vegetables in their fields. They sometimes add spices also, to give their vegetables a flavour. But this spice is altogether different to the ordinary article. It is an insect, a kind of *Rynchota* that is found under pebbles in dry river beds. When this bug is pressed it gives a very offensive smell, but the Nagas like it immensely, and these bugs add flavour to their delicacies which would otherwise be spiceless! Whenever we halted for a day or two, it was a sight to see the Nagas busily engaged in collecting and storing these bugs in hollow bamboo culms. The Nagas are very fond of meat. They eat all sorts of domestic animals including the flesh of dogs. Once even a pine marten shot by me provided them with a delicious dish.

The Nagas have got interesting folk-lores. I will mention only one story here, which is about the sexes of the sun and the moon. At first the moon and the sun were brother and sister. The moon knew certain magic by which he could convert vegetables into meat. At the request of the sun, he told her the secret, but warned her not to give this out to anyone else ; the sun in her usual feminine indiscretion revealed this to a monkey who disclosed it to all animals. At this, the moon got very angry with the sun and abused her. The sun took this to heart, and in her anger gave out so strong a heat that all trees were dried up thereby. One of the dry branches fell on the moon while he was sleeping underneath, and he was killed. The sun also died of the shock of her brother's death. When they were reborn the sun became masculine and the moon feminine.

We resumed our march on the 30th January and reached Siluk Jup in the evening. There is a salt spring on the hill from which the Siluk takes its rise, hence the stream is called Siluk Kha. Singphos of the Hukong Valley come up here every year

5. Bamboo raft on the Tanai river, Hukong valley.

6. Singpho house under construction, at Maingkwan. Hukong valley

Photo-Mech. Dept., Thomason College, Roorkee.

7. A bamboo bridge in the Hukong valley.

Photos by R. N. De. P.F.S.

8. The Singpho chief of Wallabum, Hukong valley, with his wife and retainers

by boats, and make salt by boiling down the spring water. This is their only source of salt near by. From Siluk Jup the Turong river is fairly safe for boat-journeys. I had a bamboo raft made for me, and from this place onwards I always shifted camp on my raft till we reached Sarrow on the 4th February. Photograph 5 shows a raft on the Tanai river. Sarrow is the entrance of the fertile rolling plain, known as the Hukong Valley. The total area of the valley is about 1,600 sq. miles, of rich loamy soils, "ready to laugh into a harvest when tickled with a hoe," as Mr. Allum puts it. The country is inhabited by a Mongolian people, called Singphos or Kachins. They are like the Nagas in appearance but are much more active and intelligent. They also build their houses on platforms, but these are very long and divided into compartments, so that several families can live in one house. Photograph 6 shows a typical Singpho house in the Hukong Valley under construction. They are great experts in thatching and other domestic works. I saw houses thatched with bamboo, palm and *Amoora spectabilis* leaves, and was told that they were water-proof. Singphos can make bamboo bridges of various designs of which photo 7 is a specimen. The staple crop of the Singphos is rice, but they also grow pulse, poppy, mustard, tea and tobacco.

The Hukong Valley is divided into several tribal territories, each chief having authority over his own clan. Their institutions are much more developed than those of the Nagas. Much information about the Kachins may be obtained from the excellent book written by Mr. H. F. Hertz, Deputy Commissioner of Mytkyina District. Unlike the Nagas who burn as well bury, the Singphos only bury their dead. Death, specially of a well-to-do man, is made a great occasion for drinking and dancing. A gun is also fired at intervals to announce the news of the death in the neighbouring villages. Hukong Valley has no valuable timber. The only forest produce of any importance is rubber (*Ficus elastica*). But, owing to the slump in the rubber market, tapping has been discontinued.

On our way to Shadu Jup, we passed Maingkwang and Wallabum, two most important and prosperous villages in the Hukong

Valley. In Maingkwang, one can buy rings, buttons and other small articles of amber worn as ornaments by the Assamese, Singphos and Nagas. This amber is the fossil resin of the extinct coniferous and other resinous trees that are found in the Miocene clayey beds of this valley. An amber mine is situated at a distance of 4 miles from the Lalaung village, the chief of which owns the mining areas. He lets out an area of about 10 feet square for Rs. 10 for digging out amber. There is no indication at all on the surface of the ground by which one may know where the mineral will be found. The so-called mine is nothing but a well about 6 ft. in diameter, dug vertically for 30 to 40 ft., within which amber is usually found. It often happens that after digging the whole depth, one does not find the mineral and all the labour is simply wasted. So this amber mining is a sheer gamble. Besides amber, flint is also found in these formations, but it is put to no use by the Singphos, except for lighting fires.

Before we reached Maingkwang, we crossed the Tanai river. This, as well as other small streams, bring down gold dust in their sands. Some Singphos make a living by washing gold and they are reported to earn about one rupee per day.

The next place of importance we visited was Wallabum. The chief of this place is a very influential man and has got a large number of slaves and retainers. This chief with his coat of honour presented to him by the Engineer-in-chief, together with his wife and retainers, are seen in photo 8.

From Wallabum onward, our journey was uneventful and we reached Shadu Jup, the first British Military outpost on the Burma frontier, on the 26th February. From Shadu Jup, the type of the forest changes and deciduous takes the place of evergreen, but teak did not make its appearance till we came to Laban. There is a popular belief that teak does not grow north of Mytkyina, but I found it growing about 25 miles north of it. Though originally perhaps, teak was introduced in the Buddhist monasteries, they are now reproducing naturally like any other teak in the district. We reached Kamaing, the headquaters of the sub-division, on the 10th of March. About 32 miles west-north-west of Kamaing, are the well known jade mines of Tammaw, which

a prosperous little place. Jade found there is brought down to Mogaung by mules or boats. We left Kamaing on the 11th and reached Mogaung on the 12th. Mogaung is a railway station of the Mytkyina branch line, and is also the sub-divisional head-quarters. This brought our journey to a close. The total distance we travelled was about 300 miles. In spite of the usual inconveniences one feels in this kind of expedition, through unknown and unsurveyed country, we had a most interesting and enjoyable journey and we were really sorry to find ourselves back again in civilised parts so soon.

R. N. De, P.F.S.

FROST AS A CAUSE OF UNSOUNDNESS IN SAL.

When recently touring in charge of a class of Ranger students it occurred to me that some interesting results might be obtained by felling and examining sal trees which had been damaged by the severe frosts of 1904-05, the effects of which are still plainly visible in many forests throughout Northern India. The frost of that year was so unusually severe that sal were cut back over large tracts where in normal years there is no damage whatever. Several Forest Officers at that time recorded the results of their observations in the *Indian Forester* and I think the following notes which I have extracted will help the reader to picture more accurately the exact nature of the damage which took place.

Mr. E. R. Stevens describes how throughout the Dehra Dun and up to a definite elevation on the slopes of the Siwalik range the sal forest was affected, though in varying intensity according to aspect, density and elevation. On older sal the twigs and thinner branches only had been killed, whilst poles 1 to 2 feet in girth had been killed to within 5 to 15 feet from the ground and stems under 1 foot in girth had been killed to within a few feet from or down to the ground itself. Mr. E. A. Courthope writing of the sal in the Saharanpur Division says—" Saplings have either died from the ground upwards, in which case they are sending out shoots from their roots, or they have been killed from

the crown down to a varying distance, in which case their boles are surrounded by a mass of epicormic shoots above which the dry stick which formed the leading shoot before protrudes. It still remains doubtful what the after-effects of this damage will be. It is stated by some that when the dried part falls off, one of the epicormic branches will assume the lead, in which case after a few years very little perceptible difference would be seen. Others believe that several of the epicormic shoots will assume the lead simultaneously, thus causing a sort of pollard." This was written towards the end of the hot weather following the frost. The Conservator of Forests, Oudh Circle, also wrote that in the Pilibhit Division sal trees up to 35 feet in height had in some cases been killed and that the frost had penetrated right into the forests and killed off young sal trees under a fairly dense canopy. As regards Bengal Mr. A. L. McIntire states that no damage was done to sal in the Duars and Tarai tract, but that in depressions in the Palamau and Hazaribagh Districts it had suffered to a greater or less extent, the damage varying from the killing of the outer twigs only, or of the lower or top branches (*sic*) only, to killing outright down to ground level of trees up to 50 or 60 ft. high. In the Palamau reserved forest about a quarter of the sal-bearing area was estimated to have suffered in this way.

For the purpose of my investigation two sal areas were selected in which the damage was as severe as any to be seen in the neighbouring forests, and there is little doubt that the crowns of all sal trees in both these areas had been cut back. One area was situated close to the north edge of the Gola Tappar about a mile from Gola Tappar bungalow in the Dehra Dun Division. The elevation here is 1,200 ft. The ground is nearly level with an almost imperceptible slope to the south-east. The sub-soil is deep and composed of recent deposits of boulders, gravel and sand with a fair percentage of clay. The forest, owing partly to cleanings and thinnings contains little besides sal in the overwood, and the underwood is generally open. The average density is however fairly good. The other area borders the Sitabani-Ramnagar cartroad about a mile from the Sitabani bungalow in the Ramnagar Division. The elevation is 1,700 ft. The ground slopes

gently to the south where at short distance the lower level of the Jamanpani Sot, causes the character of the forest to change abruptly. The soil and type of forest are generally similar to that of the Gola Tappar area.

In the Gola Tappar area 30 trees were felled and examined; in the Sitabani area 25 trees were taken. The trees selected averaged 8 to 9 inches diameter at breast height, the smallest being 6, the largest 12 inches diameter. The average height of the Gola Tappar trees was 62 ft. as compared with 61 ft., at Sitabani, no tree in either case being less than 50 or more than 70 feet high. The stems had been cut back by the frost to an average height of 31·5 feet in Gola Tappar and 26 feet in Sitaba ni, the height ranging from 21 to 42 feet in Gola Tappar and 15 to 42 feet in Sitabani.

Every tree had sent up new and vigorous shoots from close to the point to which the stem had died back. In 60 per cent. of the cases the shoots were single, in 39 per cent. two leaders had been produced, and in 1 per cent. (actually one tree out of 55) three leaders. These shoots averaged 6 inches diameter at base and 30 feet in length at Gola Tappar and 5 inches diameter by 35 feet long at Sitabani.

Both in Gola Tappar and Sitabani half the trees investigated showed signs of a more or less occluded channel down one face. The visible portion of this scar averaged 2·5 feet in length, but never exceeded 8 feet. It is apparently due to the cambium dying on one side of the stem to a lower point than the other. Unfortunately no observations were made to determine whether the position of the scar is correlated with the points of the compass. Had this been done it might perhaps have been possible to explain the phenomenon on a scientific basis. As occlusion of the channel proceeds, the central portion of the stem is usually found to be quite hollow and forms a most effective water trap.

With one single exception rot had invariably spread down the stem from the point to which the stem had completely died back. In three cases (one at Gola Tappar and two at Sitabani) the rot had extended down to the very base of the stem, the

average distance being 9 feet in Gola Tappar and 10 feet in Sitabani, or about 9′ 6″ for both areas combined. In recording the measurements any decided discolouration of the wood was usually considered evidence of the presence of decay, though it was necessary to exercise considerable discretion in doubtful cases. Every stem was split open longitudinally and the decay followed down from its source. This was found to be a most necessary precaution as unsound tissue in the lower portion of the stem could often be traced to the decayed bases of dead or dying side branches, and unless the decay had been followed down from the very top, unsoundness due to varying sources might easily be confused.

In 29 per cent. of the new shoots, indications of unsound tissue running up the centre of the stem were detected. The origin of this decay was, however, sometimes open to question and it was often difficult to decide whether the slight discolouration was really due to fungus or to other causes. Though in most cases it appeared as if the rot had spread upwards from the decayed tissue in the old stem, too much reliance should not be placed on this result.

These investigations then appear to have clearly demonstrated three points :—

(1) About 40 per cent. of affected stems produce at least two well-developed leaders.

(2) When a stem has once been cut back it may be confidently assumed that unsoundness will infallibly result.

(3) This unsoundness extends down the stem at an average rate of 6 inches a year.

In considering the practical application of these results it will be noted that the investigation only covered trees ranging between 6 and 12 inches diameter. The investigation should be extended to include larger girth trees, but the results already obtained seem to justify one asking what chance there is of obtaining a fair proportion of sound timber when working these forests as at present on a rotation of say 100 years.

I leave the reader to draw his own conclusions, and perhaps they will be none too comforting to those who have just completed working plans for these and similar areas. The optimist may argue that such forests are quite abnormal and that no forester can take into account the possibility of their recurrence. There are, however, no data from which the probable frequency of such abnormally cold years can be estimated with any certainty, and a wise forester will scarcely dare to trust the entire failure or success of his crop to the vagaries and uncertainties of the climate. Colonel Pearson, writing in the *Indian Forester* for June 1905 says that during his Indian experience he recollects two instances of excessive cold in the Central Provinces, one in January 1860 and the other in March 1864. But whatever the verdict may be as regards the best form of future management for these forests no one will dispute the fact that the sooner this rotten material now standing in our forests is replaced by a sound crop, the better.

A. E. OSMASTON, I.F.S.

SYSTEMS OF SALES OF TIMBER IN THE U. P. FORESTS.

There are two main systems at present for the disposal of timbers in these provinces, namely, "The Monopoly plus Royalty" and the "Lump Sum Sales."

MONOPOLY PLUS ROYALTY SYSTEM.

The present disadvantages of the Monopoly Royalty System.—This system which is supposed to be the best, is not only becoming daily unpopular with our contractors, but is, at times, a source of unnecessary worry to forest officers for the following reasons :—

It is somewhat complicated and hence not liked by the majority of the contractors especially the newcomers In fact a certain class of men belonging to Delhi, Rohtak and Meerut districts known as *khatris,* who were probably the first to take, advantage of this system, when it was originally introduced, have its monopoly throughout the Province, while the indigenous

contractors have been practically debarred from the green timber works and are limited to Lump Sum Sales of fuel and second year fellings.

The guarantee of the probable yield, which is given to the contractors at the time of auction is a great source of trouble, both to the forest officers and the contractors. In the first place it is very difficult, if not impossible, to estimate correctly, the probable yield of a coupe in the absence of any reliable yield tables, and when our forests are so extremely abnormal, that the yield tables or the experience of an officer gained in one particular locality is hardly of any practical use in another locality. Besides this, the information about the lengths of boles and the differentiation of sound and unsound standing trees supplied by the marking officers is hardly ever satisfactory, being largely based on mere guess work and varying according to the experience of the man. This record of marking officers serves as the basis on which our yield is estimated and guaranteed, with the result that if it is correct it is only so by chance. In majority of cases the actual yield either far exceeds or else falls below the guaranteed estimate. Sometimes the difference is very great, which not only brings discredit to the man who prepared the estimates of the guaranteed outturn, but there also arises a serious question of the refund of monopoly money in proportion to the shortage of the outturn. When such cases are abnormally frequent in any particular year the Divisional Forest Officer, besides getting a bad name, is worried a good deal by the contractors for refunds, which is a matter, which has probably to be decided by the Conservator.

Demand for refunds.—The contractors sometimes not only demand a refund on account of the shortage, but some compensation as well, on the plea that they have made arrangements for sawyers, carters and provision, etc., on the basis of the guaranteed yield, and have lost a good deal in making unnecessary advances. Such arguments are perfectly reasonable, but only in cases when the shortage is considerable.

Loss to Government.—In cases when the guaranteed figures are far exceeded, which is by no means uncommon, Government suffers a distinct loss by receiving no monopoly on the excess

outturn, while in cases of shortage contractors lose confidence in the guaranteed system and the bids are correspondingly low the following year, even though the estimates may have been prepared most carefully and may have been under-estimated.

New System suggested.—The system suggested is the sale of timber by *Royalty* only on the following lines :—

As in the existing system, an approximate estimate of the probable outturn of the coupe will be prepared, but will not be guaranteed. The abstract of the marking results of each coupe showing the number and species of trees marked by girth or diameter classes will be given to the contractors at the time of auction as usual, with all the necessary information required, for their guidance. According to the growth of the forests the species will have to be divided into two main groups for the facility of auction, *viz*, the principal and most valuable species concerned, being put in one group and called by its name, for instance sal in the plains of northern India, while its less valuable associates of more or less equal value being all put together in another group and called *miscellaneous* species. The contractors at the time of auction may be asked to bid on these two groups separately, as to what maximum price per c.ft. they can afford to offer to Government, without the least regard as to what the outturn of the coupe under sale would be. The approximate estimates of the yield being given merely to facilitate the arrangements of the work for the contractors.

Possible difficulties.—There is no doubt, it will afford some confusion, when sal is purchased by one contractor and the miscellaneous by another on the same area, but it will not be entirely a new thing and can be managed. Since the creation of the Utilization Circle, sal and *haldu (Adina cordifolia)* have often been sold to different contractors on the same area.

The other drawback seems to be the combining of the two neighbouring contractors, having different royalties to pay, which will induce the man with higher royalty to pass his timber under the name of the other with lower royalty. But this drawback is more imaginary than real, as this inducement is also possible in the present system, that is to say, the man with a higher

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monopoly per c.ft. may pass his timber under the name of a neighbour with a lower monopoly and thus reducing his yield below the guaranteed estimate, may obtain a refund to the advantage of both himself and his neighbour. Obviously this defect is of no importance and may be controlled through the felling staff as it is done now.

Expected advantages.—The contractors instead of paying the price of the coupe by instalments, will deposit sufficient Royalty in advance to keep their export going, and there will be no difficulty about realising the last instalment, such as is sometimes experienced under both the existing systems. This system it is hoped will give equal chances to all commers and break the monopoly of the *khatris* (particular class of contractors) which is another source of trouble, as they tend to combine. It will be fair both to the purchasers and the department without any chance for the grievances of the former and the worries of the latter, regarding the guaranteed outturn or the refund.

LUMP SUM SALES.

Disadvantages.—The second system by Lump Sum is a sort of gamble, often resulting in abnormal profit or loss to the contractor. It is, therefore, not suited for the sales of sawn timber which is the main source of our revenue. It is also often difficult under this system to realise the last instalment.

Advantages.—It is very simple and is best suited to fuel and other minor second year operations, with a view to clear the coupes of all the miscellaneous stuff left after the main fellings, or where the kind of the produce is of a more varied nature

Possible Modification in the present Monopoly Royalty System.—In case the proposed purely Royalty system may not be considered suitable for certain reasons, a modification in the present Monopoly Royalty System is at least very desirable for smooth working. That is, the present scale of Royalties on various timbers may be enhanced to its maximum capacity, thus leaving a mere nominal margin for monopoly bids at the time of the auction. This will reduce the chances of abnormal profits and losses on either sides and the refund of monopoly if any will also be nominal.

Considering all the above points and the advantages and disadvantages connected with the present Monopoly and Royalty or the Lump Sum Systems, the suggested pure Royalty System or the modified system will be much simpler both for the contractors and the forest department and the chances of excessive profits being made by either Government or the contractors will be reduced to a minimum, with a consequent reduction in the legitimate grievances of the contractors and the difficulties of the forest officers.

MD. HAKIM-UD-DIN, P.F.S.

OXIDATION OF TANNINS IN MYROBALANS.

Brief summary.—It has been found that the tannin content of myrobalans is considerably reduced by the ordinary process of drying, as a result of enzyme and other activities going on in the cell. This harmful effect has been obviated, by cutting the fruit in slices and drying. A much improved product is thus obtained, which gives clear aqueous solutions and these do not deposit ellagic acid so quickly. The use of antiseptics with a view to preserve the myrobalans against the destructive action of fungi is also recommended. Dr. Mann's researches on the fermentation of tea having already established that the chemical reaction consists essentially in an oxidation of the tannin, as a result of certain oxidases and peroxidases; it occurred to the author to investigate whether similar changes take place in the ordinary drying of myrobalans, a process which extends from 15—20 days, is there any considerable fall into the tannin content, and if so, could it be avoided?

The following experiment was therefore performed :—

1. Some chebulic myrobalans ; (*Terminalia Chebula*) commonly known as *harr* were plucked when almost ripe in March last. Half the quantity was crushed and dried in shade—an operation which took three days. The other half was left to dry, with the skin of the fruits intact, and took three weeks for a satisfactory drying. Both samples were powdered, dried at 100° C and the tannin estimated as gallo-tannic acid.

The 1st sample thus yielded 27·5 per cent. gallo-tannic acid.
The 2nd " " 20·0 " " " "

In the second case, it was also noted that considerable quantities of brown colouring matter is formed as the result of tannin oxidation and later on that the aqueous solution is more liable to a quick deposition of ellagic acid.

The obvious solution of the problem was to hasten the drying of myrobalans.

2. A fresh sample of chebulic myrobalans was therefore collected. One ha'f was crushed and dried in shade. The other was cut into small slices (4—6 according to the size of the fruit) and dried similarly.

The tannin content in the former case was found to be 27·5 per cent. gallo-tannic acid, that in the latter being somewhat higher— from 28 to 28·5 per cent.

To all appearance the second product was an improvement on the first and it was thus established that in order to preserve the maximum amount of tannins in myrobalans, the fruit should be cut into slices and dried quickly. The product so obtained has a light yellow colour and retains the peculiar aromatic smell, characteristic of the fruit, as contrasted with the present market stuff, a dark brown mass, with no or in some cases even a sour odour.

Experiments similar to the above were performed with emblic myrobalans (*Phyllanthus Emblica*) known in these provinces as *aonla*.

The tannin content of a sample of sliced myrobalans dried in shade was 24 per cent. gallo-tannic acid, while that of a similar sample allowed to dry with the skin of the fruits uninjured, was 22·0 per cent. gallo-tannic acid.

Some experiments on the use of antiseptics in the drying and preservation of myrobalans were also performed with a sample of *Phyllanthus Emblica*. It was noticed that the moist myrobalan slices are liable to be infected by *penicillium* and this fungi under conditions of moisture rapidly spreads and destroys the tannin. The following will give an idea of the rate of destruction.

In a sample of crushed and dried *Phyllanthus Emblica* the tannin content was originally equivalent to 51·2 per cent. gallo-

tannic acid. The same sample was moistened with water and inoculated with *penicillium*. After four days the tannin content was only 28 per cent., considerable amount of yellow colouring matter was developed and the aqueous extract rapidly precipitated ellagic acid in flakes.

Investigation showed that the infection and subsequent destructive action of the fungi could be avoided by the use of a minimum of ·5 per cent. toluene or ·25 per cent. of phenol or treatment with sulphur dioxide.

A few general observations in the end might not be out of place. The export of chebulic myrobalans in 1919-20 was 1,858,000 cwts. valued at Rs. 1,01,31,000. If the method of preservation outlined above be followed, their present tannin content would be increased by at least one quarter as much again, and if the myrobalans are valued for the tannins alone, such a course would materially benefit the trade. The exact significance of the work would be more adequately realised when we come to the tanning extracts, an industry very likely to develop in the near future. Here the value of a tanstuff is adjudged by the ratio between the tannins and the soluble non-tans and if therefore we obviate the conversion of 15—20 per cent. of our tans into soluble non-tans, the strength of our tanning extracts would be doubly greater.

A factory thus handling large quantities of myrobalans would find it advantageous to chop the fruit and pass it through a continuous rotary drier, through which are drawn hot flue gases, admixed with a small percentage of sulphur dioxide, by means of an exhaust fan. Working in double or triple "effect" would probably be more economical. The product thus dried and disinfected, would be safer to store and more convenient to handle.

ADDENDA.

Although the present knowledge of the chemistry of tannins does not warrant any rational explanation of the interesting sequence of changes going on in the cell, as indicated already still a few lines might be hazarded, as the result of some thought and observation.

The following is a set of analyses of two samples of *Terminalia Chebula*. A is the fruit allowed to dry intact and thus decay

by respiration. B is the fruit sliced and dried rapidly (needless to state, both samples are taken from the same lot):—

A.		B.	
Tans	26·1 per cent.	Tans	30·7 per cent.
Non-tans	26·9 ,,	Non-tans	22·1 ,,
Insolubles	40·2 ,,	Insolubles	40·4 ,,
Moisture	7·8 ,,	Moisture	6·8 ,,

Expressed on the anhydrous material these figures would stand as follows:—

A.		B.	
Tans	28·3 per cent.	Tans	32·9 per cent.
Non-tans	28·1 ,,	Non-tans	23·7 ,,
Insolubles	43·6 (by difference)	Insolubles	43·4 ,,

We have now to consider:—

(1) That the presence of tannin prevents pectic transformation and fermentation of sugars.

(2) That the ratio of Co_2 evolved to that of oxygen absorbed in course of respiration, is in this particular case 2 : 1 nearly.

(3) That respiration is in almost all cases accompanied by hydrolytic activity and further oxidation of one or more of the decomposition products generally follows.

(4) That the sum of tans and non-tans in the above case, is almost the same in both instances.

It might, therefore, suggest itself, that in course of respiration of myrobalans complex tannins are first hydrolysed to simpler units (such as digallic acid for gallo-tannins) and these are further oxidised by protoplasmic or enzymic activity, with the formation of non-tans as represented below:—

$$2\,(R-CooH) + o_2 = 2\,(R-oH) + 2\,Co_2$$

Tans 1 Vol of o non-tans 2 Vols of Co_2

The author wishes to express his indebtedness to Mr. M. B. Hudlikar, M.Sc., for much valuable discussion on the subject.

A. N. SRIVASTAVA.

THE VALUATION OF AMERICAN TIMBER LANDS.

By K. W. Woodward.

Published by Chapman & Hall, Ltd., London.

The aim of the book is to give some idea of the timber resources of the United States and at the same time information likely to be of use to the investor, timber cruiser or student of forestry.

As a basis for his work the author divides the country into various types of forest, his type being an area with approximately the same climatic, topographic and soil conditions and hence to a large extent the same species. In most cases it is necessary to redivide his main types into various sub-types.

Practically each type occupies a chapter and he gives twenty-two main types but this includes as separate types Alaska, Porto Rico and the Philippines. In addition there are four general Chapters on Timber Valuation, Land Valuation, Titles and the Outline of a Report on a Tract of Woodland.

Each type is treated under the heads of General conditions, Timber Valuation, Land Values and Titles. He commences with a general description of his type, its climatic and topographic features, its vegetation, the dangers it is subjected to and a table of rates of growth. The rest of the chapter indicates the methods usually employed in valuation, the percentage of the area which should be done to form a sufficiently reliable estimate of values, the cost of the work, often very usefully expressed in terms of man hours or horse hours, the prices lumber is likely to fetch, the stumpage profits, an idea of the value of the land employed, etc., etc.

The book contains a great deal to interest any forester but on the other hand as it deals with types in a definite country, and as its main object is not silvicultural but actual values, it naturally is not a book which will be widely read except in the country of its origin. Even the values given are not of very great use to us in India for, as the author rightly says, they can only be broad averages and naturally vary very greatly from place to place and in any case the prices and costs given are often very different from those at present in force.

On the other hand the work is ably done and gives one an insight into the trouble taken by the American investor to value his product and it is very different from the haphazard methods of so many Indian contractors where the purchaser tells his agent to value the coupe, the agent tells his munshi, the munshi asks the forest guard who gets the information from a local coolie.

To those foresters interested, or whose work is connected with costing, this book will undoubtedly give many ideas of the usefulness of allotting their expenses carefully to the item to which it is really chargeable. A point which strikes one forcibly is that anything in the nature of a complete enumeration seems never to be done and the maximum enumerated is to be not more than 25 per cent. while 5 per cent. or less is often considered sufficient. In the tropical areas the percentage enumerated drops to $1\frac{1}{4}$ only.

It is worth noting that General volume tables cannot be applied direct as the local conception of timber is so variable. This is a problem which will be even more important in India. Volume and yield tables in India must be built on some standard idea of volume as local conversion varies often in the same division. Factors must then be found showing the relation between the standard and the local result and those applied in using standard tables.

The only portions of the book of real local interest to Indian Foresters are those which concern the forests of Porto Rico and the Philippines. There mangroves, tidal forest, moist deciduous

forest, rain forest, diptero carps, etc., occur, all of which are interesting and familiar to us.

While appreciating the value of the work from the American point of view it is not a book which will be of direct use to the ordinary forester in India.

S. H. H.

FORESTRY IN FRANCE.

La Grande Forêt de Tronçais.

(*By Professor E. P. Stebbing.*)

I.

The great Forest of Tronçais, perhaps one of the oldest in the Midi, is situated in the department of Allier, and is remarkable for its similarity in some aspects of the Forest of Dean in Gloucestershire. That this resemblance of the two forests is not greater at the present day is due to the fact that Tronçais has been under more or less conservative management for some 350 years or so; whilst up to comparatively recently for well over a century the Dean was the playground of amateurs, possessing little knowledge of forestry science. That a considerable part of the Dean could produce such oak as are to be seen in Tronçais admits of little doubt. And they would be standing there now were our race animated by the spirit which breathes in the following allusion to Tronçais. " Cette forêt, gloire incomparable de notre France, doit être conservé, telle que les siècles nous l'ont léguèe ; et nous devons â notre tour, la léguer à nos déscendants intacte, plus belle même s'il se peut. Les forestiers décideront dans quelle mesure at par quels moyens la chose est réalisable."

During the Napoleonic Wars and at Trafalgar many of the British ships were built of oak from the Dean, whilst the timbers of many of those in the French Navy came from Tronçais. A century later during the Great War, Tronçais was again called on to provide first-class oak timber of magnificent size and length for French naval requirements. Owing to the fault management of the past, the Dean contained no such timber,

Abundant evidence exists that Tronçais from very early times formed an important centre of development, for tumuli and other traces of the Celtic races can be seen. The forest was of strategic importance to the Romans in their struggles with the northern tribes, and they established several important towns linked up with a road system; Roman remains are still to be found. With the weakening of the Roman Empire the tribe of Bituriges obtained the upper hand. By the 10th century the "cite' biturige" had disappeared, and the region known as the *Pagus Burbunensis*, became the first home of the Seigneurs, subsequently styled Dukes, of Bourbon. The forest proved of great importance alike to the Roman legionaries and the barbarian tribes, both as a stronghold and, with the development of trade, as a source of wine casks (which it still produces), which replaced the leather bottles of the Romans. It also provided the fuel required for the iron industry which Cæsar established amongst the Bituriges, and the pannage required for the feeding of swine which was so important in those days. Many parallels to this history are to be found in the Forest of Dean. With the increase of allotments for cultivation on the boundaries of the forest the owners had the right, or used it, to collect fuel and litter in the forest, and to graze their animals therein. In the 13th century the ownership of the forest was assumed by the Dukes of Bourbon, and the area was maintained for hunting purposes, much as the Norman Kings created the Dean, Windsor Forest, and so forth for a similar purpose. The area of the forest had by now considerably decreased. The old forest had stretched unbroken between the two rivers, Cher and Allier. In the 7th century the disciples of St. Columba began to found monasteries in the neighbourhood of Tronçais, and these foundations and priories so increased in number as to make considerable inroads on to the forest area The occupants also made use of the forest in a most wasteful fashion. The same contraction of the forest took place in the Dean—in both regions we find many place-names ending in "wood" or "forest" which are now far without the existing forests. The respective areas of Tronçais and the Dean are 27,250 and 15,000 acres. The Bourbons were attainted in 1527

and ownership of Tronçais was then assumed by the State, under whom it has since remained.

The forest, and especially the outer areas, went through various vicissitudes, and were badly treated up to the middle of the 17th century. It was the rise to power of Colbert, the great Minister of Louis XIV, which saved Tronçais and other forests in France from the inevitable ruin and disappearance which threatened them. The far-sighted Colbert originated a forest policy for France, a policy which has had remarkable after-results. He appointed a Commission in 1670 to examine the state of Tronçais Forest, the boundaries of which had recently been laid down on the ground, many of these old pillars still existing. The Commission, in reporting on the forest, pointed out the great damage under which it was suffering from bad and illicit fellings, loppings, grazing, fires and encroachments. They discovered extensive heather-covered blanks, with scattered old oaks, 300 years and more in age, standing on a destroyed forest soil. The scheduled areas at this period were as follows :—(1) 675 acres of well-grown young oak high forest; (2) 3,275 acres of old open high oak forest, destitute of young growth beneath; (3) 23,310 acres exploited in old fellings and ruined; with heather-covered areas containing scattered old oaks and much browsed patches of young ones.

It is difficult, almost impossible, when examining Tronçais to-day, to realise that the above description was ever applicable to the present forest.

The working plan drawn up in 1670 for the amelioration of the forest prescribed a conservative annual cut of 62½ acres amongst the remaining old oak to provide for naval requirements and a planting scheme for restocking the destroyed areas at the rate of 250 hectares (750 acres) a year, reserving, where possible, 10 old stems per hectare. This plan aimed at a rotation of 200 years for the oak. Its prescriptions were carried out with great care during the following 110 years (1779), and the forest was to a great extent restored. The magnificent stands of old oak seen to-day in the blocks known as La Plantonnée, Morat, La Pelloterie, and elsewhere are the results of the work put in hand by the 1670 Commission,

They average 108 trees to the hectare, at least ⅔ oak and ⅓ or less beech, with an understory of beech. Average diameters of oak—Breast high, 30 inch.; mid. diam. 24 inch. Average height of bole, 64 feet; of tree, 100 feet. Average vol. of bole equals 200 cubic feet, and of crown 14 cubic feet. The oak dating from this period have provided the chief timber of fine size cut in Tronçais during the past 85 years. And the areas from which it has been cut were described in 1670 as barren or in very poor condition, thus indicating what continued scientific conservative management can do.

It is of interest to note that even before the Colbert Commission started work at Tronçais, John Evelyn, in England, was preaching his planting campaign, and had published the first edition of his *Sylva*. The Dean profited by that campaign during the succeeding two centuries, after which the management of the forest went to pieces.

But Tronçais was also to experience vicissitudes. During the last third of the 18th century there was a great development of the iron industry, and the forges established in connection with the Berry mineral deposits used enormous amounts of wood; having exhausted the Berry forests, they demanded wood from Tronçais. A road was opened out through the forest connecting the two rivers, the Cher on the west and the Allier to the east. By a decree of the Council of State in 1779 the working plan was modified, and the east and west section of the forest were placed under a rotation of 45 years, with an annual cut of 157½ acres in each section. Fortunately the central portion of the forest, comprising 8,538 acres, was created a reserve, the rotation being maintained at 200 years. It is due to this foresight that Tronçais at the present day possesses the magnificent oak alluded to above. Between 1779 and 1788 iron works were opened out within the forest, and concessions of forest were granted to the owner. He was granted a 40 year lease on an area of 6,390 acres, with permission to clear (cut) one-fortieth of the area per year. The mineral was transported from the forest by pack mules, and permission was accorded to graze these animals in the blank areas provided these were sown up with acorns during the last 10 years

of the lease, a clause which was not fulfilled. The mules, which were very numerous, grazed unchecked in the forest as well as in the blank areas.

By 1804 it had become evident that all was not well with Tronçais forest, and careful examination was made of the whole area. Its condition in all, save the reserved part, was deplorable. It was pointed out that the measures instituted under the orders of Colbert in 1670, had resulted in the production of magnificent crops of high oak forests of great value.

The steps taken in 1779 had resulted in the destruction of the forest in the eastern and western parts. The rotation was too short for oak, and the annual felling areas more than twice as large as they should have been.—[*The Scotsman.*]

TRACTORS *vs.* HORSES IN THE WOODS.

BY GEORGE A. MACKIE.

[Figures available from recent Operations favour Mechanical Log Haulers.]

Woods operations for the season of 1922-23 have served to demonstrate on quite an extensive scale, the important part which tractors may be depended upon to play in the solution of the winter log-hauling problem in the Canadian woods. Hitherto there has been a tendency on the part of lumbermen to accept with a trifle more than the proverbial grain of salt the claims made by tractor enthusiasts as to the performances of these machines. These doubts have been fostered and strengthened by past experiences in the woods with tractors of various kinds which, while of real value in the work for which they were designed, had no real place in woods operations. The difficulty in the past seems to have been in securing the requisite traction power without having, at the same time, to accept a prohibitive weight in the tractor itself.

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During several seasons past, the problem of hauling out the cut of logs to the main stream or nearest railway has been becoming increasingly difficult. Horse haulage was slow and

expensive and the total haul by such a method was not, in many cases, commensurate with the investment in the operation. Woods foreman were confronted with the eternal question of getting their logs out at a price which would show a balance on the credit side for the season's work

Information obtained by the writer from the men in charge of a number of tractor operations in the Canadian woods for the season just ending, would seem to indicate that the problem of economical log-hauling has been solved by them. As a further assurance of this it has recently come to our attention that one of Canada's most reliable and conservative woods experts has become a convert to tractor haulage. After investigating the possibilities and performances of tractors in recent woods operations he has revised his method of calculating merchantable timber by increasing his distances from the railway or main streams from his former limit of five miles to a distance of from 8 to 10 miles as the length of haul which serves to best demonstrate the economy and efficiency of tractor operation but there are records available of distances both less and greater than these, in which satisfactory results have been obtained.

In one particular operation which was visited by the writer that of Messrs. Murray and Omanique near Madawaska, Ontario, a Linn logging tractor was hauling a total of 320 hemlock logs of from 16 to 24 ft. in length on seven sleighs and the tractor itself over a distance of about 4 miles with remarkable ease and all desired speed. The road was in no sense an easy one but included many steep hills—which were sanded—and several short curves. This particular tractor was making seven round trips in 24 hours—4 by day and 3 at night and was averaging well over 2,000 logs per 24 hours day on this operation.

Some interesting figures as to operating costs of tractors in woods operations are furnished in a letter from T. S. Woollings & Company, Limited, Englehart, Ont. According to the data compiled by this operating company, the Linn logging hauler tractor supplied by Messrs. Mussens Ltd., Philips Place Building, Montreal, proved a substantial saver of both time and money over previous results obtained by horse haulage.

6

Mr. Woollings states that the tractor hauled a total of 7,000 cords of wood a distance of 6 miles between the 7th day of January 1923 and the 10th day of March 1923, at a total operating cost of $ 2,050 including gasoline, oil, and 2 men's time operating the tractor. This, as Mr. Woollings points out, brings the actual hauling cost to 30 4-10 cents per cord. Comparing this figure with the previous haulage costs, when horses were used, which worked out at from $ 1·50 to $ 1·60 per cord, the difference is quite notable.

Based on these figures the actual saving in money on the operation above described reached very substantial figures. The saving per cord between $ 1-50 per cord and 30 4-10 cents per cord on the total haulage of 7,000 cords works out to the very handsome sum of about $ 8,400. Or put in another way, the tractor method of haulage shows a saving of about 80 per cent. when compared with horse haulage.

The facts and figures above presented are surely significant and worthy of the consideration of all those to whom the problem of the log-haul has become a vexed question.—[*Illustrated Canadian Forestry Magazine, April 1923*].

RANDOM NOTES ON LOGGING IN INDIA.

By J. Lees Harrison.

I have been out in India over a year now and am carrying on the good work and defacing the country side. Coorg is my sphere of operations. No doubt when I mention Coorg you are as wise as you were before. As a matter of fact, it is a small province some 2,500 square miles in extent in the south of India and lying west of Madras Province. It lies really in the Western Ghats. It might hardly be said to be much in the public eye but it is a case of "guid gear in wee bulk."

When I first arrived in this country at Bombay and reported my arrival there, advising that I was posted for duty to Coorg, the „powers that be" accepted my statement with resignation but expressed doubts as to the exact whereabouts of my destination. It was known to be down south somewhere, but no one was sure

how to get there, I tackled the invaluable Cooks, however, and after a close scrutiny of maps, guide books, time tables, etc., they ran Coorg to earth. The nearest railway station is in Mysore, nearly 60 miles away. However when I did arrive in Coorg, I found it was well worth searching for. It is a hill province some 2,000 to 3,000 ft. up, and consequently the climate is normally delightfully cool compared to the plains. From October to April, the weather is excellent. The monsoon begins in May or June and then the purchase of an umbrella is a sound investment. The umbrella is opened up then and is not taken down again until the end of September. Incidentally our rain-gauges are specially made for us to enable us to measure the rainfall correctly; a normal gauge would register for about half a day and then overflow. Last July for three consecutive days the rainfall was eight inches, eleven inches and nine inches. That is a fact. At the end of last wet season I was quite relieved to find that my feet were not webbed.

Forest exploitation work here is going ahead well. That may sound rather bombastic as regards myself, but what I really mean to convey is that this branch of the forest work is well supported by those in high places. Coorg is rich in timber and her timber resources have been nibbled at so far. I should say, for her size she is one of the richest provinces in timber in India.

There are really two main timber areas as regards schemes for extraction—one in the south-east and the other in the south-west. The eastern forests are not being worked to anything like their full extent at present, but that is only a matter of time, and at present we are finding our feet. The extraction of logs is being carried out at present by means of ordinary bullock and buffalo carts, each cart taking one log. The timber found there has a good market value, the principal species including such timbers as teak (of a good quality) and rosewood; (both species you are acquainted with). C. S. Martin has worked out a scheme on a commercial basis for extraction on a large scale, and that we hope, will be put in operation in the near future.

Exploitation work going forward.—Exploitation is going on at present in the Western Ghat forests and there I am endeavouring to justify my existence. The area to be tapped there is some 65,000 acres in extent. The timber lands lie in

the valley of the Barrapole River and in the valleys adjacent to it. Except in parts along the slopes adjacent to the main river itself, the timber has never been touched, and there is a splendid stand. We hope to be able to extract some 40 tons per acre (incidentally a ton is on an average, 50 cubic feet). At least 15 tons per acre will be what is known as first-class species. Most of these species are little known outside India so far, but we are fairly certain that it will be only a question of time before they have a name in the world market. Our first-class species include *Artocarpus hirsuta (ainee), Dipterocarpus indicus (kalpaini), Dysoxylum malabaricum* (white cedar), *Hardwickia pinnata (chonapaini), Calophyllum tomentosum (poon), Hopea parviflora (iripu).* These species are all fairly heavy (average 50 cubic feet to the ton). The lumber produced is ideal, practically free from knots and with few flaws. For the most part, the trees have long, straight stems and make ideal logs as regards handling. Only logs over 18" in diameter are extracted ; the average diameter is about 2'-6". As regards length, we extract the logs in 18 to 35 feet lengths.

The names of the species I have given may convey nothing much at present, but I give them to you so that when they become well known in the timber world, you will have been well informed for some time back.

As regards the forest policy, these forests, as are the majority in India, are State owned, and consequently the question of regeneration is carefully studied. It has been reckoned that to produce a mature tree in these regions some 60—100 years are necessary. The suggested scheme is to log over some 650 acres per annum and thus, even taking the longer period of 100 years before the trees have grown again, by the end of a century extraction can be started at the first area to have been cleared. It sounds very fine, and as the first forest engineer in Coorg I would seem to head a chain of forest engineers who will go on for all time. The operation here may be said to be of the Tennyson Brook order, and may go on for ever, irrespective of the coming and going of forest engineers.

Logging Railways employed.—As regards the works, some 13 miles of two-foot gauge forest railway has been laid up the main valley, and the work is practically completed now. The nature of

the country is such that little can be done as regards branch lines and spurs, and to transport the timber from the surrounding slopes to the tramway, other means of communications will have to be used. The country around is very hilly and the slopes are steep.

The felling heretofore has been done with axes alone. This last year, with what one might term varying success, I have been endeavouring to get the coolies accustomed to the use of the saw. Where I am handicapped is that the first inhabitant in this country never seems to have used a saw and, therefore, the trouble is that the methods as practised by their forbears weigh very heavily with them, and I am deeply thankful that their great great-grandfathers did not cut down trees with a pocket knife or wait until they blew over, otherwise it would be even harder to have the trees felled at all. I used to think at first that their attitude was due to laziness, but I realise now that it is really diseased conservatism.

Patiently I have pointed out how much quicker and easier it is to fell trees with a saw. The coolies' attitude seems to be that the sahib has some mad scheme in his head, probably due to a touch of sun, but that they had better try to humour him and help him in his folly. The usual result of two men with a saw is an "S" cut in the tree. Naturally this tends to bind the saw from the very start. When the saw has gone in some little way and finally binds, they stop with a relieved air and philosophically await further orders. One might almost say there was an air of "I told you so" about their attitude. The cause of the trouble is pointed out and they are shown that a straight cut must be made. What seems to be a dawning intelligence in their faces makes hope show her head once more. Then to set to work with vigor (eastern vigor) and make a cut even more wavy than before, and the saw binds after about four pulls. (Need I say I am following with much interest the development of types of power saws for trees felling.)

One great problem as regards here is going to be the transport of the logs from the stump to the tramway. So far we have been employing elephants and teams of buffalos, but for long hauls that method is rather too slow and costly.

Experimenting with Pole Tramways.—I am laying stretches of pole tramway of one to two miles, but I have not got the system in operation yet. The trucks will run on two 6-inch to 8-inch diameter poles, and to prevent the poles from spreading there will be cross poles or sleepers every 10 ft. or more. The present stretch of track is laid more or less on a down grade all the way, with a maximum grade of about 1 in 30. The present idea is to haul a set of two trucks either by buffalos or by an elephant. The disadvantage of such an arrangement is that the load is limited to one set of trucks, and also there is difficulty as regards braking. A buffalo's normal pace is gentlemanly two miles per hour. Like the coolies, however, they are very conservative, and although well behaved enough when hitched in to a cart or hauling a log, the idea of hauling trucks on a pole tramway does not appeal to them. On their first few efforts in that line they endeavour, more or less successfully, to pull the trucks off the line. An elephant is much better for this sort of work if he can be spared, but to teach an elephant to pull the trucks on the pole tramway one requires the patience and knowledge of an animal trainer with years of experience. When the elephant is first hooked on to the truck he is deeply suspicious. When the "mahout" persuades him to pull and the truck begins to move, he moves also, and in top gear. Yes, he moves, and although an elephant is not built on the lines of a greyhound, he can certainly cover the ground through the jungle. The elephant will sometimes go off through the jungle, taking with him as much of the truck as can manage to hold together. When an elephant is thoroughly frightened there is not stopping him quickly. Cussing an elephant is not much good; he has rather a thick skin, a brain the size of an orange, and no finer feelings that I have noticed, so what is the use? I have heard a fluent logger giving an impassioned address to a refractory "donkey" merely to relieve his feelings, but I was not long enough in the States to pass out in logging elocution, and in any case cussing is very hot work out here.

Hopes for the Tractor.—I have been trying to get details of any tractor of sorts which could operate successfully on the pole tramway. It is not as if the pole tramway were the main means

of transport, it being subsidiary, although important enough in itself. What I should like to do would be to able to bring down two or three sets of trucks at a time with adequate braking and be able to take them up a slight grade, if necessary. The sort of machine I thought might do was one after the nature of a Fordson tractor fitted either with spool wheels or wheels similar to those fitted on the trucks at present. I take it, the trouble would be to get sufficient friction for the driving wheels to grip on the rough poles, unless the poles were specially prepared, and at the same time prevent the track from spreading. I do not know if any of the companies on your side have had any experience with traction of this nature, but I should be very grateful for advice or for details of any good results obtained with pole tramway traction. I don't wish anything elaborate or expensive, as I do not want to spend much on laying the pole tramway track.

A Holt 10 ton logger caterpillar has been ordered and I hope to get delivery of it by the end of April. That, I hope, will do away with a lot of our transport trouble.

As regards hauling of logs over short distances and handling of logs, elephants are in a class by themselves. A good elephant will move a log of from two to three tons on the level or downhill. The trouble in using elephants is that they cannot haul uphill, and on a long haul they are not economical, in my opinion. What I hope to do in future is to use them on 100 to 200 yards haul in the jungle making jackpots to be cleared by the tractor or other means of transport. A good elephant manœuvring a log is a spectacle one never grows weary of. He will pull, push with head or foot or use his trunk or tusks in handling a log, and when a log is jamming he is extraordinarily clever at understanding where and how to apply his strength. The spectacle of the elephants working with the logs would interest Charles Murphy, of the Weed Lumber Co., greatly, I know. During my very pleasant stay at the camp near Weed, Cal., he designed a bummer to be used with an elephant. I still have that sketch. It is certainly rather too vague to be used as a working drawing, but in any case I have refrained from making use of it from a fear that he may have already patented it under the title of

the "Murphy Mastodon Bummer." Elephants differ in their methods. We use both departmental elephants and also hire Malabar elephants. Our elephants when actually pulling use chains, but the Malabar elephants haul the logs by means of a thick rope which they hold in their teeth.

On the two-foot gauge railway I have only one locomotive at present, and that is a seven ton machine. A ten ton locomotive is on order and should be along any day now.

The floating of the logs is rather a problem. Not only is the stream bed rather rocky in places, but the nature of the logs does not assist the solving of the problem. Many of the first class species do not float, and other agencies have to be used to buoy them up. Before I had thought of taking up forest engineering I used to be greatly interested by the accounts of Stewart Edward White and like authors how the progress down stream of a "logger rampant, on a log flottant, with a peavy couchant." During our trip in the States I had an opportunity in Idaho, along with another of our fellows, of walking on logs. Walking would hardly describe it, as the performance consisted of diving off and coming up to breathe now and again. This was not what we had intended to do, but that represented the nett result of our labours. Onlookers appreciative of our efforts assured us afterwards, when they had regained their powers of speech, that our aquatic display would assure us of a hearty welcome at Los Angeles. I may say that was the worst log pond I had ever tasted, and I can truthfully state that I never drank anything worse all the time I was in the States. To resume the question of floating, owing to the bad state of the river and the lack of buoyance of 50 per cent. of the logs, many of the rafts have to consist of single logs. These are buoyed up by bamboos and reeds on either side. Lower down the river, rafts can be assembled of from 10 to 20 logs, which greatly facilitate transport.—[*The Timberman, June 1923.*]

RED COLOURING OF LEAVES.

SIR,—In the article "Œcology of Indian Savannah Plants," appearing in the July number of the *Indian Forester* Mr. Sher Singh states (on page 365)—

> "Now, the best way to exclude heat rays or red rays is to let the light filter through a layer of red colouring, which, according to the laws of optics, absorbs complementary blue rays, and lets the injurious red heat-rays pass out. It might be argued that although red rays have come out on the other side of the plant, they have passed through the leaf and have, therefore, heated the leaf in their passage. This is not true, because, light to be effective, must be absorbed. Thus although the sun's rays pass through air, the atmosphere is not heated except by conduction or convection."

The general conclusion he arrives at, namely, that leaves turn red to minimise the amount of heat absorbed, may be true but the explanation quoted above is entirely incorrect. One of the preliminary facts in optics is that all sense of colour is due to the reflection of the colour-ray seen, and the absorption of the other rays of the spectrum by the object under observation. To make it a little clearer, we see a lamp blacked surface to be *black* in sun-light, because it absorbs all the colours and reflects none—for black signifies the absence of colour. Similarly, a red leaf is seen to be red because it reflects only the red rays and absorbs the rest.

It is, therefore, both unnecessary and incorrect for Mr. Sher Singh to state that a red leaf lets the red heat rays pass *through* a leaf without affecting it, for the simple explanation given above suffices to show that a red leaf absorbs no red or heat rays, not by allowing them to pass through, but by reflecting them. His explanation is also unjustifiable for a leaf being opaque, cannot be compared to the atmosphere, as in the case he instances, of the sun's rays passing through the atmosphere without heating it.

B. A. CARIAPA, P.F.S.

LUMBERING AND WOOD WORKING INDUSTRIES IN THE U. S. A. AND CANADA.

Misstatement corrected by the author.

SIR,—My attention has recently been drawn to a remark in the above book which is misleading as it stands and likely to prejudice Canadian Manufacturers of Sawmill Machinery.

The remark is contained in Volume II, Chapter 6, page 116, dealing with Sawmills and reads as follows :—

> "A good deal of American machinery finds its way into Canada, but Canadian mill machinery does not go into the States."

In making the above statement I was under the impression that it was correct, the reason given me being that Canadian manufacturers could not compete in the States with American manufacturers owing to heavy import duty imposed by the American Government. Even though such trade is seriously handicapped by the duty in question I have recently learnt that at least one well known Canadian firm is doing considerable business with its machinery in the States. I desire, therefore, to express my deep regret to the Firm in question and any others similarly situated for the remarks above quoted.

F. A. LEETE, I.F.S.

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STATE CONTROL OF PRIVATE FORESTS.

Judging from the standards of progressive European countries it is estimated that forests extending over about 18 per cent. of total area will be required to satisfy the timber requirements of India when economic conditions become intensive as in the European countries. Whereas India has only 10 per cent. of her total area classified as permanent or Reserved State Forest at present. Hence it is necessary that some sort of control must be exercised over vast private forests, to check wasteful exploitation of the country's natural resources, in the interests of national welfare. Various measures have been tried in different countries to secure sound management of private forests on the principle of sustained yield, when required by national safety or national economy, at the same time interfering least with the individual's rights. Sometimes these measures take the form of mere encouragement and providing of technical supervision and sometimes of actual control, even prescription of a Working Plan.

In France the tendency at the time of the Revolution was towards nationalisation of forests, but in the reaction that followed a strong individualistic movement set in, and private forestry has always played an important part, since then. The State now only adopts measures to encourage sound management of private forests and does not interfere with the proprietor's rights. The most important legal enactment concerning private forests is Art. 219 of Code Forestière passed on June 18th, 1859, which lays down that no private owner can clear-fell his forest without notifying the fact to the sous-prefecture at least 4 months in

Photo-Mech. Dept., Thomason College, Roorkee.

Assistant Conservators of Forests joining the Indian Forest Service in 1923.

advance. This refers only to the ordinary forests, a very strict law, of course, exists as regards "protection forests."

The Swiss Forest Law of 11th October 1902 lays down in Art. 26 that private forests may be arranged in groups for management under the State officials, and the State also contributes 5 to 25 per cent. of the emoluments of forest officers appointed to look after private forests. But the most important measure is that which lays down that the total afforested area must not be diminished. Thus a sound hold is maintained over the management of all private forests.

The Forestry Act of 1919 gives powers to the British Forestry Commission under Clause 3 (*d*) to undertake the management or supervision of woods belonging to private persons or corporations; otherwise there is no direct interference with private forests in Great Britain except in the case of settled estates whose present holders are not allowed to utilise more than their proper share of timber —[Schlich.]

In Prussia where the State owns about 50 per cent. of forest no control over private and communal forests is deemed necessary, but in other German States control, in some form or other, is exercised over private forests.

In Austria and Hungary where the State owns 16 per cent. and 7 per cent. of forests respectively some sort of control is considered necessary; whereas in Russia where the State owned 66·4 per cent. of forests before the Bolshevik régime, and did not have the means of even managing them properly, no control was exercised over private forests.

In Spain "which has perhaps suffered more from the effects of forest destruction than any other country" (Dr. Fernow), the State owns only 4·5 per cent. of forests and so has to exercise a control over 80 per cent. of communal and private forest.

All these considerations lead to the conclusion that some sort of State supervision is considered necessary in all cases where the State does not own forests adequate to the needs of the country even in countries where the national aspect of forestry is fully well realised and where forest conservancy has been practised for centuries as a national art. What form that supervision must

take depends upon the needs of the country, the degree of civilisation, the national traits, attitude of the people towards forests and above all on the degree of recognition by the people of obligations carried with forest ownership But in all cases it is the duty of the State to enforce stringent protective measures whenever the interests of the cummunity are in danger of being sacrificed to satisfy the whims of capricious owners. In India the story of private forestry is a gloomy chapter in the history of forest conservancy, vast areas of forests belonging to the Zamindars and landowners containing very valuable species and of great potential value to the nation, have been subjected to indiscriminate fellings with consequent impoverishment, merely to swell the immediate profits.

In order to introduce sound management on the principle of sustained yield in these forests the Indian Forest Department has now and then acquired private forests on a system of *lease.* This system has worked admirably well without any friction, and it is impossible to think of a system of State control showing greater respect for the individual's rights. In fact, a wiser step in relation to private forests, in danger of destruction, cannot be placed to the credit of any forest administration in the world.

Some time ago the valuable teak forests belonging to the Zamindar of Ahiri in the district of Chanda were thus brought under the control of the Forest Department of Central Provinces. The Zamindari is situated in the southern portion of the Chanda district with Ahiri as its headquarters—a distance of 60 miles by road from Ballarshah, the terminus of Wardha Ballarshah section of G. I. P. Railway, and 70 miles from Chanda, the headquarters of the district. The estate was originally a feudal grant made about 6 centuries ago by one of the Gond Rajas of Chanda, to an ancestor of the present Zamindar. The Zamindar paid a small tribute in recognition of the sovereign authority, but otherwise he exercised supreme control in the days of the Gond Rajas, and it was only after the district came under the British in the year 1853 that his legal position in respect of proprietorship was questioned, and his title thereto admitted only conditionally, *i.e.*, subject to the conditions of succession, loyalty and good adminis-

tration. In 1893 the estate descended to the present Zamindar but owing to bad administration was placed under the Court of Wards in 1902 and still continues to be under it.

The forests leased contain in places teak superior to Allapill teak which is supposed to be the best teak in Central Provinces, but unfortunately it has suffered considerably in the past from shifting cultivation, fire and extravagant fellings, and what remains now is mostly unsound. Reckless shifting cultivation was practised till 20 years ago and still needs supervision. Compared with the adjoining Government reserved forests which have been under scientific management for about half a century these forests bring home to even a casual observer the advantages of managing forests on sound lines.

The following summary represents the conditions of lease which was affected on 21st May, 1920 :—

(1) *Area.*—Lease covers 3 blocks, Chandra, Jimalgutta and Korepalli.

(2) *Period.*—Ordinarily for 50 years expiring in 1970, unless the Court of Wards having relinquished its management of the estate, the Zamindar gives 6 months' notice of termination of the lease.

(3) *Revenue.*—All revenue from forests produce, grazing, etc., will be realisable by the lessee.

(4) *Rent.*—100 per cent. net grazing revenue, 90 per cent. of remaining surplus revenue.

(5) *Expenditure.*—Maximum fixed at Rs. 12,000 annually. It will consist of—

(*i*) $\frac{1}{6}$ pay of Divisional Forest Officer, South Chanda, and his office establishment ;

(*ii*) $\frac{1}{6}$ pay of Ahiri Leased Range staff.

(6) *Audit.*—Balance-sheet to be supplied to lessor annually by lessee.

(7) *Legal status of forests.*—Lessor agrees to have such provisions of the Indian Forest Act (*vii* of 1878) applied to the Leased Range as lessee may desire.

Villages aggregating 883 acres of the block come under the lease.

The above conditions of lease are imperfect in more than one way, but the greatest drawback is probably not transferring the villages enclosed in the leased blocks to the Forest Department, owing to which much difficulty is experienced in getting labour for forest works. Another drawback is perhaps the fixation of a maximum limit for expenditure, as this will seriously tell on the total net revenue. It will be necessary to spend large sums on cultural operations for a long time, if it is desired to improve the growing stock, in addition to expenditure on the utilisation works.

Although the manifest result of scientific management will be mostly confined to an improvement of the growing stock, the financial results achieved are much better than anticipated at the time of the preparation of the Working Plan in 1917—before the forests came under the control of the Forest Department.

It will no doubt take a long time to undo the harm that has been done to these forests under the old régime by people, who have the curious mentality of regarding forests as inexhaustible sources of revenue, but now that the forests are put under the proper treatment their capital value is bound to increase with a corresponding increase in the annual revenue in due course of time.

S. A. VAHID, I.F.S.

THE STUDY OF A PRIMITIVE COUNTRY AND ITS PEOPLE.—BEING A SHORT ACCOUNT OF THE PAWRAS AND BHILS OF THE AKRANI PARGANA, WEST KHANDESH DISTRICT, BOMBAY PRESIDENCY.

Preface.—This short account of the Pawras and Bhils of the Akrani pargana owes its origin to the fact that as Divisional Forest Officer of North Khandesh Forest Division and *ex-officio* Assistant Collector, Akrani, exercising II class magisterial powers, the writer frequently had to decide disputes and pass judgments on domestic and general legal questions in the Akrani pargana.

Up to the present no survey settlement has been introduced in Akrani owing to the peculiar circumstances of the country,

but in 1915, at the request of Mr. E G. Turner I.C.S., Collector of the district, the writer drew up a scheme for introducing a simple form of settlement in this hilly chess-board of cultivated fields and woodlands: This matter is still in abeyance. As no settlement has been completed and introduced questions of ownership and transfer of land, etc., have to be decided by custom, and it was with the hope that an account of some of the customs of the Pawras and Bhils of Akrani might be of use to his successors and of interest to others that the writer asked Messrs. B. J. Joshi and L V. Gonsalves, who were for 6½ and 2¼ years, respectively, Range Forest Officers and *ex-officio* Mahalkaries of Akrani, and also the Rev. A. P. Franklin, for many years a Missionary in Akrani, kindly to supply him with the notes on which much of this account is based. The writer's sincere thanks are due to them for their cordial response to his request.

The scope of this monograph has been somewhat amplified at the suggestion of a friend who thought that a more general account of these hill forest peoples would prove of interest to readers of the *Indian Forester.*

This account will supplement and in certain respects correct the information about Akrani given in the *Gazetteer* of West Khandesh district which has not been revised for many years.

The writer himself held charge of the office of Divisional Forest Officer, North Khandesh, and was *ex-officio* Assistant Collector of Akrani exercising II class magisterial powers from 7th May 1913 till 20th June 1919 during which time the notes above referred to were prepared, but pressure of work has prevented earlier collation and publication.

Country.—Akrani pargana, sometimes spoken of as "Dhadgaon Mahal" after the name of its chief village, comprises about 382 sq. miles of which 304 sq. miles are reserved forest. It is all very hilly and is situated to the north of Shahada and Taloda Talukas, West Khandesh district. The western portion comprises two more or less parallel ranges of the Satpura hills which enclose an irregular table land and merge into an intricate network of high hills on the east culminating in the large flat topped hill called "Toranmal.". The northern range drops

1. A batch of forest fire watchers, in Akrani.

2. Pawra headman of an Akrani village and his wife.

5. A typical Bhil woman of Akrani, and her children

Photo by Rev: A.P. Franklin.

3. Headmen of four villages, situated on the banks of the Nerbudda.

4. The headman of Toranmal village and his two shikaris. All are Naikada Bhils.

Photos by Forest Ranger L.V. Gonsalves.

steeply into the river Nerbadda on the north, and the southern range rises sharply from the Tapti valley plain on the south.

The pargana is entered from the Tapti valley plain by bridle paths through two main passes, *viz.*, the Chanseli pass and the Dara-Mandvi pass. There are at present no cart roads leading up to Akrani, but one was surveyed years ago and subsequently abandoned. The road has now been re-aligned and is designed to connect Shahada in the Tapti plain with Dhadgaon in Akrani, going up *viâ* Dara and Mandvi. Construction work on this project was begun at the Dhadgaon end as a famine work in 1919 and has since been spasmodically continued. During the last 10 years or so a few bullock carts have been introduced by the Missionaries residing at Mundalwad, Akrani and by a few others, but their use is at present very restricted owing to lack of cart tracks. Provisions are carried to and from the plains on pack animals or on headloads along bridle paths which are annually improved and repaired by the Forest Department.

Dhadgaon with the adjoining village of Roshmal is situated in the middle of the most fertile portion of this populated table-land and is the centre of the official life and trade of the pargana. Here is found the old fort containing the Range Forest Office which is also the Mahalkari's *kacheri*. It must have witnessed many stirring scenes in the disturbed times of old. But now all is peace except for the noise from the beloved country liquor shop on high days and holidays, for the Bhil loves his tot! Outside the fort are the Government Rest House, Range Forest Officer's bungalow, and quarters for the other Forest, Police, Revenue, Excise and Medical Officials, etc. and last, but by no means least, must be mentioned the Government *Mhowa* spirit distillery, which will again be referred to in another paragraph.

Climate.—The temperature varies from occasional light frosts in the pleasant but somewhat feverish cold season to about 105° F. in the hot season Thus the heat is less trying than that of the Tapti valley plain in the hot season; and Toranmal, though very difficult of approach, except through Barwani State on the east, is a delightful haven of rest for the jaded official who can

enjoy peaceful nature in the grandeur of solitude. Toranmal is a fairly well wooded plateau, about 16 sq. miles in area, surrounded by steep scarps, and takes its name from the *toran* bush *(Ziziphus rugosa)* whose fruits are much sought after in famine years, but its chief source of delight is the large artificial lake measuring some $1\frac{1}{2}$ miles round, on the side of which the Forest Rest House is built. The Hill is fortified with double walls of considerable strength but they have now fallen into ruins in many places. Numerous finely carved stones are found scattered about indicating the former presence of some fine Hindu temples, but very little seems to be known of the history of this delightful fortified hill-top beyond the fact that the Mahabharat mentions Yuvanashva, the ruler of Toranmal, as fighting with the Pandavs, and tradition says that while Sita was resting in a neighbouring ravine Ravana came and carried her off to Ceylon while Rama, her husband, with his brother Laxman were out hunting. Toranmal is also said to have been the seat of the rulers of Mandu.

As the plateau has an average elevation of some 3,500 ft. and the shade temperature never exceeds 85° F., I believe proposals have been made from time to time to make a sanatorium here for the neighbouring districts, but it has been condemned on account of the mists which are said to enshroud the hill during the monsoon months. These mists cannot be very bad, however, as the rainfall of the district is so low, and at Toranmal probably does not exceed 30 to 35 inches. It is believed that the real inner reason for neglect in developing this delightful spot is its inaccessibility. It is too far from roads and railways to become a first class hill station but a little co-operation with and from Barwani State might make it possible to take a road up from the plains along which local people could climb in their modest "Fords."

Forests.—The hills are covered with deciduous forest comprising teak (*Tectona grandis*), *sadada* (*Terminalia tomentosa*) *dhaura* (*Anogeissus latifolia*), *khair* (*Acacia Catechu*), *mohi* (*Odina Wodier*), *salai* (*Boswellia serrata*), *gorad or kinai* (*Albizzia procera*), *sisham* (*Dalbergia latifolia*), *tiwas* (*Ougeinia dalbergioides*), *biya*

(Pterocarpus Marsupium), *aola* *(Phyllanthus Emblica)*, *charoli* *(Buchanania latifolia)*, *mhowa* *(Bassia latifolia)*, *mango* *(Mangifera indica)*, bamboo *(Dendrocalamus strictus)*, *etc.*, *karvi* *(Strobilanthes callosus)* is also very common on the higher hills and tall grass everywhere abounds. As the rainfall is low, the dry season long, and the forests are frequently overrun by severe fires, the stocking is thin and the trees are generally small except in ravines. Formerly very exaggerated ideas prevailed as to the excellence and density of the Akrani forests. Fine trees do exist here and there, but extraction is difficult. When the road from the plains, which is now under construction, is completed, the extraction and export to the plains of some of the better teak and *tiwas* will be a paying proposition. The main purpose of the road is for purposes of administration, however. Until a railway is constructed north of the Tapti, and a larger market stimulated, there will be little scope for extraction of forest produce in large quantities from the more inaccessible hills of Akrani.

Although the forests are extensive, forming part of one of the largest continuous forest tracts in India, and practically no people live in the eastern hills, game cannot be considered plentiful. It is said that wild elephants abounded in the hills up to the 17th century. Tiger, panther, bison, sambhur and black bear are found in small numbers, while wild pig, barking deer and four-horned antelope are fairly common. The great heat and lack of drinking water in the long hot weather is probably responsible for the lack of big game. In places peacock and jungle-cock abound.

The Khandesh Bhil is one of the best *shikaries* the writer has ever met, but the Pawra is not of much use in this respect. It is wonderful to watch a Bhil pick up the track of an animal on parched ground. It is a great joy to a Bhil to accompany an officer on a shooting expedition, and when the officer is gone he keeps his eye in by many an illicit hunt with his friends armed with bows and arrows and an old muzzle-loading gun or two. Nothing comes amiss to him from a hare, which he kills with a well-aimed axe, to a doe sambhur!

Population.—Most of the people live in the western portion of Akrani which forms an undulating table-land surrounded by higher hills and comprises a chess-board of more or less cultivated land and woodland surrounded by reserved forest on the higher bordering hills.

At the census of 1921 the population of Akrani, which chiefly comprises Pawras and Bhils, was 12,982 (6,813 males and 6,169 females) compared with 12,506 in 1911. Roughly speaking, we may say that half are Pawras and half are Bhils. These reside in some 130 villages of which those to the West of the Chanseli-Dhadgaon bridle path are mostly inhabited by Bhils while those to the East are mostly inhabited by Pawras except in the extreme East and North-East. The Pawras are particularly numerous around Dhadgaon where the land is most fertile.

The term Bhil is said by Wilson to be derived from *billee*, the Dravidian word for a bow, which is the characteristic weapon of the tribe, whereas Sanskrit lexicographers derive it from the root *bhil* meaning fallen or degraded. The references to Bhils in Sanskrit literature show that the Bhils were both hated and feared nd were gradually pushed back by the invading Aryans. The Bhils are supposed to be the "Pygmies" of Ctesias (400 B.C.) and the "Poulindai" and "Phyllitae" of Ptolemy (A.D. 150).*

The wild woodman of the Satpuras is dark, lean but well made, active and hardy with cheek bones, wide nostrils and in some cases almost African features. There are, however, considerable variations, some being almost sharp in features. This must be due to intermarriage, possibly with Rajputs, in former unsettled times. Despite their lean appearance they have great powers of endurance and will, on occasion, walk uphill and down dale 50 miles in a day. It is interesting to note that they are so used to walking single file amongst the hills that when they make occasional expeditions to the large bazars in the plains they continue to walk in single file.

Bhils are fond of spirits, improvident and thriftless, and loathe steady work, but at the same time they are simple, chatty, hospitable, faithful and honest, and have some sense of humour.

* Tribes and Castes of Bombay—*Enthoven.*

Their loathing of steady work is so great that they will scarcely stay on famine works in times of scarcity, and departmental road and building works can only be completed with difficulty by exercising strong moral pressure and relieving the labourers every 15 days. Their simplicity is such that the wily trader of the plains always gets the better of them when they sell their spare grain and jungle produce. On the whole they are but indifferent cultivators, and their houses, which are grouped together, are inferior structures of wattle and daub with thatched roofs.

The Pawras as a class have better features and are lighter in complexion and more refined than the Bhils, and are said by some to be of Rajput origin (*vide Gazetteer* of West Khandesh district, page 95). They are excellent cultivators and are very thrifty. Their houses are frequently not grouped together but placed each in man's own field and are very neat, being made of carefully woven bamboo walls with thatched or even tiled roofs. They generally have two gables, one-half of the building being occupied by the family and the other half by the cattle.

The dress, ornaments, habits and language of Pawras and Bhils differ somewhat. As regards ornaments Bhil women wear heavy brass leg bangles, which may reach from the ankle almost up to the knee, and necklaces of many rows of cowrie shells. Such ornaments are never worn by Pawra women; they generally wear silver ornaments such as anklets, bangles above the elbow and necklets. There is a tendency nowadays, however, for the wealthier Bhil women to follow the Pawra fashion in wearing silver ornaments. These ornaments are all made at Dhadgaon

The Pawra considers himself to be of superior caste to the Bhil and will not eat food or drink water from the latter's hands, although he will drink country spirit from a cup which a Bhil has put to his mouth. A Bhil, however, will take food from a Pawra.

Enthoven, in his Castes and Tribes of Bombay, says "that the so-called Bhil tribes are merely clans or families, differentiated according to the extent to which they have adopted Hindu customs, inter-married with other races, or are affected by local nfluence. Why this natural process of differentiation should be

accelerated by the Bhils themselves is difficult to explain, unless the influence of the caste system be taken into account—a system which was undoubtedly quite unknown to the original Bhil." This statement is somewhat interesting for the Rev. A. P. Franklin of Mundalwad, Akrani, says that prior to the survey of 1903—06 both Pawras and Bhils used to eat with the Christian Missionaries and Christian converts, but that at that time some 30 Brahman Surveyors tutored them in the duties of caste, since when Pawras and Bhils no longer eat with Christians.

Both among Pawras and Bhils of Akrani there are certain sub-divisions known as *kools*, *i.e.*, clans or sub caste. These *kools* take their names after the names of the villages inhabited, and the members of one clan frequently consider themselves superior to those of another. Theoretically a member of a higher *kool* is not supposed to eat from the hand of a member of a lower *kool*, but nowadays this is not strictly followed. Mr. D. R. S. Bourke, I.F.S., who is acquainted with Akrani, traces these *kools* to the old tribal system under which the people were divided up in tribes, each under a definite hereditary chief, who was often known as *naik*. Most of these *naiks* were suppressed by Outram with his Bhil corps, which was raised in 1825, when the Bhils were giving much trouble by raiding the villages of the plains. In this way the Bhil tribal system was broken up for reasons of public security, much as the Scotch clan system was broken up in the 18th century after the rebellions of 1715 and 1745.

The few Bhils who inhabit the Toranmal plateau differ from the ordinary Akrani Bhils, and are known as Naikada Bhils. They are hardier than the Pawras or the ordinary Akrani Bhils and speak a different dialect. They appear to be the remnants of a clan which formerly gained its livelihood by *kumri* or shifting cultivation in the eastern hills.

Bhils in general have been described as lawless, but the Akrani Bhil is not addicted to dacoity like the plains Bhil. The Pawras and Bhils of Akrani are all ignorant cultivators, and are for the most part truthful, law abiding, and mild, though they have very short and hasty tempers. Thus, though theft is almost unknown in Akrani, murders which are committed in the heat of a

quarrel, are unfortunately somewhat numerous; the three principal causes of murder being (*i*) animosity on account of one man taking another's fields, (*ii*) the faithlessness of a wife, or (*iii*) a quarrel under intoxication, which is their worst vice. After committing a murder the murderer is frequently found to have hanged himself on the branch of a tree near-by. In other cases he gives himself up to the custody of Government authorities, making a clear statement of confession. Rarely he hides himself in the forest for a short time but eventually gives himself up to justice.

The consumption of *mhowa* spirit plays an important part in all social functions, whether to celebrate a birth, death, marriage or religious festival, and result in crime and general deterioration of the race. Judging from liquor sales the people must spend much more on liquor than on clothes, and hence the poorest, who *will* drink, suffer greatly in winter for lack of a blanket which few seem to possess.

The liquor problem is a difficult one in Akrani as the illicit distillation of *mhowa* spirit in the hills is so easy, but the present policy of Government is to maintain an outstill at Dhadgaon for the preparation of a specially coloured liquor which is sold in the hills only at cheap rates so that illicit distillation is scarcely worth while. Nevertheless illicit distillation still goes on to a certain extent, for home prepared liquor is regarded as essential in the performance of certain ceremonies. The extent of the vice may be estimated to a certain degree from the fact that in 1916 the average land revenue for the whole of Akrani was Rs. 3,000 while the contractor of the outstill paid an annual license fee of Rs 12,500 and succeeded in making a handsome profit.

Mhowa flowers are not used entirely for the production of liquor but are frequently dried and smoked with locallygrown tobacco. The dried flowers are also ground up and mixed with *bajri* flour to make a sweet form of *bhakar* (bread cakes). *Mhowa* seeds (*tolambi*) are also pressed cold and yield an inferior edible oil into which *bhakar* is sometimes dipped before being eaten.

The Pawras and Bhils of Akrani are more luxurious living than the Bhils of the plains in that practically everyone provides

himself with a cot to sleep on. But while enjoining restful sleep he frequently denies himself the luxury of a bath for perhaps a week at a time !

The people start cultivation in the middle of June when the monsoon breaks, and finish harvesting their crops in February or March. The next two months, *viz.*, April and May, are known as the *pauna* or visiting months and during this season the people spend their time visiting each other all over Akrani. When entertaining his visitors a Pawra or Bhil must provide adequate supplies of liquor and food to his guests unless he wishes to be looked down upon by the rest of the community.

In a footnote on page 85 of the *Gazetteer* it is stated that Bhils will never eat monkey-flesh. This is not confirmed by local Missionaries nor by what the writer has heard.

At the conclusion of the war the then Mahalkari—Mr. L. V. Gonsalves, who takes great interest in the wild tribes—invited several of the more adventurous Pawras to accompany him to see the peace celebration at Bombay. A good number at first wanted to go, but the number eventually dwindled down to three owing to their fear of being drafted into the labour corps of war time, of which they had heard most absurd rumours. After donning the irksome but regular Hindu-dress in place of their free and easy loin-cloths they ventured down from the hills and eventually reached the railway. This was a source of amazement, but it was as nothing compared with their impression of the sea when they reached Bombay. They were taken to various places of interest including the museum where they at first thought the stuffed animals were alive, but their greatest wonder was when they saw the long lines of fine buildings in the Fort. These they compared with their beloved hills and asserted that such buildings could not have been raised by man but must be the works of God Would that we could mete out the same praise on all the buildings in Bombay !

Language.—As regards language it is stated on page 84 of the *Gazetteer* that in Khandesh the Bhil dialect is a mixture of Hindustani and Marathi with Gujarati endings, and that Akrani Pawras and western Bhils speak among themselves a dialect of

Gujarati unintelligible to the plain's Bhil. Again, it is stated by some that there was an original Bhili language, but it seems more probable that the Bhils speak a dialect in accordance with the proximity of the larger languages. Certainly those who live in the west understand Gujarati more or less. However this may be, it may be said there are three dialects in Akrani, *viz.*, Akrani-Bhili, Pawri and Naiki-Bhili spoken in the eastern hills. It seems strange that Bhils and Pawras who live in the same village continue to speak their own separate dialects even when talking to one another.

[*To be continued.*]

H. W. STARTE, I.F.S.

FIELD CROPS IN TAUNGYA PLANTATIONS.

Introduction.—The object of this paper is to put forward reasons to show the necessity of studying the field crops grown in our *taungya* plantations. This means of regenerating the forest has now assumed an important position in Burma, and on its success will depend the future of very large areas of our most valuable forests. But hitherto whilst the Forest Officer has selected the species of tree to be grown and ordered the manner of growing it, the selection of the field crop has been left entirely to the *taungya* cultivator and no regulation has been attempted. Now the interest of Forest Officer and *taungya* cultivator are not identical. With the former the establishment of a successful plantation of trees is the vital object, whilst he wishes the *taungya* cultivator to make a comfortable livelihood both to ensure good work and because he likes to see those assisting him flourish. The *taungya* cultivator, on the other hand, is primarily interested in obtaining a good field crop on which his bread and butter depends and his interest in the tree crop must naturally remain subservient to this. Like all agriculturists he is intensely conservative in his methods. To obtain the best results with the plantations these two points of view must be reconciled, which means compromise. If the Forest Officer does not effect this compromise, no one else

will, and it is hard to see how he can effect it when his ignorance of field crops leaves him with a one-sided knowledge

Need to study field crops.—The broad objects of the *taungya* plantation method are to (*i*) clear the ground, (*ii*) introduce the tree crop and (*iii*) keep down weeds, all at the minimum cost. The *taungya* cutter clears and burns the area and does a good proportion of the weeding in the normal course of cultivating his crop. His extra work lies in the dibbling of seed or seedlings and the more thorough weeding demanded, for which he frequently obtains a monetary reward in addition to other concessions, provided he hands over a successful plantation. But a great deal of the suppression of weeds must be dependent on the field crop covering the ground, and since there are few field crops which will not over-top tree seedlings, at any rate the more valuable species, during their first rains, a certain amount of shading with consequent loss of growth has to be faced Here is an obvious subject for study to attain the objects of the *taungya* plantation with the least sacrifice of growth of the seedlings. At the end of their first year seedlings spaced 6′ × 6′ will very seldom cover the ground sufficiently to prevent a strong weed growth, and although in some cases the second year's growth may rapidly shade the ground too much to permit of further cultivation of field crops, in other cases the area remains sufficiently open. In the latter case the cultivation of a second year's field crop will not only reduce weeding expenses but afford the additional advantage of working the soil between the lines. In the case of the first year's growth of the seedlings having been retarded (*e.g.*, by defoliation), or of failure, a second year's cultivation of field crops is even more obviously advantageous. Now this second year's cultivation may mean a change of crop, the soil being unable to produce an equally exacting crop in the second year, or it may involve the cultivation of a crop which matures early before the tree canopy starts to close up. These considerations demand a knowledge of field crops and especially in the case of introducing the second year's cropping to a new division. It will very likely be said that the broad cast sowing of other species between the staked lines will effect the same objects as the second

year's cropping, but if the subsidiary species can be sown a year later there is wider choice without risk of their overtopping the main species, and wider spacing of the latter may be facilitated. Nor are we yet certain of obtaining a complete crop of subsidiary species.

Examples.—In the present state of our knowledge it is not possible to do more than cite a few examples of the effects of different field crops, not necessarily those universally cultivated. Paddy does not cause appreciable shade until the middle of the rains, but from then onwards to December a good crop causes dense shade. Although many species put on a considerable growth during the cold weather, the seedling which has suffered this suppression remains behind its more fortunate fellows. With vigorous teak the difference may disappear in the second rains, but with slower growing species or a failure of early sowing the result will be reflected in subsequent weeding expenses. Indian corn is a crop which is reaped fairly early and lends itself to spacing calculated to modify the degree of shade. Cotton can be spaced so as to afford valuable shade during the first hot weather. Tapioca (*kalawpinan*), planted after the rains have well set in, demands the ground be kept very clean and does not shade the seedlings until the rains are failing, when it gives useful protection from the hot October sun. Being a root crop its harvesting in the cold weather causes the soil between the lines of seedlings to be thoroughly worked and finely divided. Sugarcane being mounded up enables the tree seedlings to be raised out of a too wet soil.

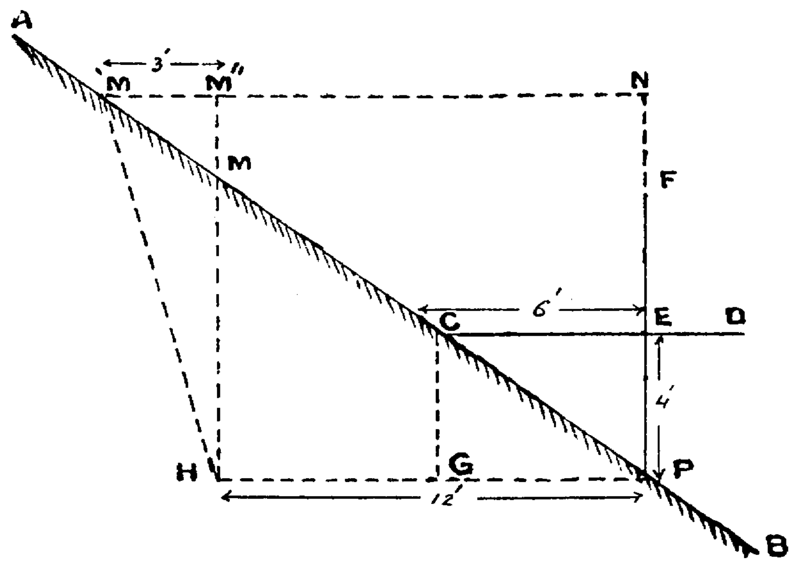
Lines of study.—The points requiring study in field crops are the suitability of different crops to various soils and their possibilities for a second year's cropping of the *taungya*. The time of planting and reaping with the period during and degree to which they shade the seedlings are points of great importance. Control of the density or spacing of the field crops may yield important results, and although this tends to reduce the *taungya* cultivator's profit within limits, suitable compensation is possible. The degree to which it is possible and profitable to thus control the field crops is a matter for investigation with a view to ascertaining the most

advantageous compromise. Side issues which will possibly be solved during any such investigations are the extension of *taungya* to soils at present uncroppable on this system and the improvement of the *taungya* cultivator's profit by the introduction of improved species or more suitable crops. The writer is well aware that there is still a large amount of investigation into regeneration of tree species required but feels that the study of the field crops in our *taungya* plantations is by no means irrelevant and cannot longer be neglected. To mention one possibility only, a suitable field crop may go far to solve the difficulty of raising *kanyin* (*Dipterocarpus alatus*) in *taungyas.* Although the Forest Officer has proved himself in the past to be as nearly a complete Jack o' all Trades as exists, it is fair comment to say that a study of field crops is outside his scope. But this is surely a case for an agricultural expert to work in collaboration with the Forest Officer.

This paper is a plea for action, and does not pretend to do more than indicate some of the more important directions in which further information is required. The writer's hope is that it may lead to discussion, ending in a fruitful investigation.

J. B. MERCER ADAM, I.F.S.

A PRACTICAL METHOD OF MEASURING EARTHWORK ON HILL-SIDES AS ADOPTED IN THE MAGWE FOREST DIVISION, BURMA.



A. B. = Hill-side.

P. = Peg along road alignment on hill-side.

C. D. = Horizontal graded rod into feet and decimals of a foot.

P. F. = Vertical. do. do.

M. H. = Height of cutting on hill-side.

H. P. = Width of road or cutting.

G. C. = Mean height of cutting.

If H. P. width of road be 12′ let vertical rod P. F. cut horizontal rod C. D. at 6′. Then read the height of P. E., *i.e.*, G. C. at E. on the vertical rod where the horizontal rod cuts it, in order to get horizontal rod C. D truly horizontal, a small rectangular spirit level can be placed on the rod and held with the hand that holds the rod. One man can use both the rod by holding a rod in each hand.

G. C. × H. P. = sectional area of M. H. P.

If the face of cuttings is to be sloped back as in M'H it is best to draw up a table to show how far M' is to slope back from M., *i.e.*, to show M'M".

The following table is used in the Magwe Division :—

Height of cutting.	Sloped back.
Under 3'	*Nil.*
3'—6'	1'
6'—8'	2'
8'—10'	3'
10'—13'	4'

Thus if P. E reads 4' H. M. will be 8'. According to the above table 8' cutting requires 3' sloped back, So M'M" = 3'

$\therefore$ M' N. $= 3 + 12$
$= 15$

Put horizontal rod C. D. so as to be cut by vertical rod P. F. at $\frac{15}{2}$ or 7·5' and proceed in the manner as explained above for upright cutting.

If the hill-side is too steep mean heights for fractions ($\frac{1}{2}$ or $\frac{1}{3}$) of the width of the road can be found and add up together to get mean height for the whole width of the road.

HATIM TAI, P.F.S.

[We have submitted the above article to a Forest Officer who has studied such questions, and he makes the following remarks and criticisms.—HON. ED.]

" The mathematics of the method are correct and it is a convenient way of roughly estimating earthwork on moderate slopes. Trouble will be experienced when the side-slope of the ground is very low, when the length of the horizontal rod will be very long and also when the side-slope of the ground is very steep, when the height, at which this rod has to be held will be inordinately great.

The method of avoiding these difficulties, as explained in the last paragraph, involves a good deal of trouble and does not altogether solve the question, and I think that the method should be confined to side-slopes, which are neither too flat nor too steep.

There is one other point as regards the tables :—

" Height of Cutting "—" Slope-back. "

The figures given in this table cannot be used with all types of soil and the figures given correspond to back-slopes of 68 deg : 12′ to 80 deg : 33′. These are much too steep for ordinary soil and one usually reckons on 45 deg : as being the average back-slope."

TWO ROGUE ELEPHANTS.

In the month of December 1922 when the rice crop was just beginning to ripen I was on tour in the Goalpara Forests in Assam, which extend for a distance of some 10 to 15 miles southwards all along the Bhutan boundary. The land along the south edge of the tree forest is all under rice cultivation and liable to severe damage from wild animals from the forests, and in particular from elephants.

Elephants generally move down southwards during the rains and many of them remain within easy reach of the cultivated land until after the rice crop is reaped. Apart from herds which may vary from five or six animals to twenty or over and which move over considerable distances, and retreat to the hills in the hot weather, there are always a number of solitary males who do not seem to migrate to the hills, but who live in fairly well defined beats in grass or evergreen forest on low ground or along rivers all along the south edge of the forest throughout the year. These may have been driven out of the herds, or may of their own accord have adopted a solitary and usually bad tempered existence, and it is these who usually do the greatest damage to crops.

Many of them are well known to the villagers and appear year after year to take heavy toll of the ripening rice.

Villagers erect look-out huts between the edge of the forest and the fields, sometimes built in trees or on high poles, and sometimes on mounds of earth with a substantial ditch round them on which most of the men of the village sleep at nights armed with such firearms and spears as they possess and with a plentiful supply of bundles of dry reeds for torches and flares. The fire-arms are usually of a most primitive type, old muzzle loading guns, with barrels often worn to almost the thinness of paper, and bound to the stock with plaited cane. From such guns from which one would almost hesitate to fire a blank charge they will fire a charge of buckshot, or a heavy home made lead slug, without apparent ill effect.

Villagers living and cultivating land within the boundary of Reserved Forest where game protection is enforced as far as possible have usually only been allowed to possess guns, the barrels of which were cut down to about 18 inches, merely as game-scarers to prevent their use for illegal game poaching, but in view of the damage done by the solitary males it has been necessary to allow villagers to own some long barrelled guns also.

A number of the more well known of these solitary male elephants have been proclaimed as rogues, to be shot at sight, but the villagers weapons are inadquate for the purpose and as the place is very inaccessible for sportsmen armed with heavier guns (and even then it would mean a considerable amount of arrange-ment and by no means a certainty of success), it is not often that a chance occurs of killing one of the rogues.

These from experience learn that they have little to fear, and raid the fields night after night.

The villagers join together and advance on the intruder shouting in a body with guns, spears and flares and generally manage to drive him off into the forest for an hour or two but when things are quiet again, he comes back and the performance is repeated. Some of them do not always allow themselves to be driven off without protest and some of them will not go till the line of villagers and flares comes almost up to them, and even sometimes charge and rout the villagers, very occasionally killing

a man. These elephants sometimes also discover that among the houses in a village there are rice granaries and will deliberately go to a village and smash houses down. Possibly the discovery is made by the elephant in the first instance wandering up to the village and pulling a house down out of sheer mischief, they are wantonly mischievous, and any hut left unprotected in the forest will most certainly sooner or later be pulled to pieces by elephants. They are most destructive to boundary pillars and bridge hand rails which they seem unable to resist the temptation to pull up. Or damage to villages may be started in a fit of *musth*, when the elephant is ready to go for anything he sees, in a most reckless way.

Last December I had many complaints from one village that a well known rogue *makna* (tuskless male) was visiting their crops every night, and even in the day, and that they could do nothing with him as he refused to be driven off, and charged them if they attempted to do so. He had been seen in the fields by a subordinate Forest Officer riding home on a bicycle who left his bicycle in the forest and walked round another three miles, and he had held up a train load of timber on its way from the forest on the 2′ light railway.

I told the villagers to let me know next time he was out in their crops and accordingly about two days later they came one afternoon to say the elephant was out in crops close to railway and in full view. I sent off a couple of tame pad elephants to wait some distance from where he was, and went up on a trolley with my wife, the wife of my Conservator T., and S. my assistant who came with a ·500 Express in support of my ·475 H. V. double barrelled rifle. My wife and Mrs. T. got on to the pad elephant from which they could see him standing in the rice at the edge, of some tall grass while S. and I. went on foot along the line to where we could see him, and then turned off towards him through some low grass. He took no notice of us, and allowed us to approach to the edge of the grass about 35 yards from him across an intervening rice field.

He was standing broadside on, and as he then seemed inclined to move I fired hitting him in the head, he reeled round turning broadside on in the reverse direction, and a second shot in the head knocked him over not to rise again.

He had a small pair of tushes damaged and discoloured, and shewed obvious signs of *musth*, which probably accounted for his aggressive mood. He was a magnificent animal, his forefoot measured 5′ $1\frac{1}{2}$″ in circumference and he taped, measured as accurately as possible between pegs at the shoulder, 10′ 3″.

Three days later after dusk my mahouts reported that another rogue, a tusker, was in their crops and had very recently smashed in a house and killed a man. The previous night he had come to my baggage elephants and gone to attack a tame tusker, but had been driven off.

T. and I went out on foot through the rice fields to one of the look-out huts on the ground where we found a number of men with flares. They told us the elephant had just moved off into the jungle. Scouts were sent round the fields but could not see him, so we returned to dinner. Before we had finished, the men came back and said he was out again, right in the middle of the fields. Back we went, with a company of flares and walked through the rice. I confess I did not at all like it, mine being the only rifle with the party and a standing rice crop being an impossible thing to run in if occasion arose, while on a dark night flares only showed things at all clearly about 25 yards away and very indistinctly beyond.

We saw a big thing just recognisable as something lighter than the surrounding darkness, but I could not be sure which end was head and which tail so did not risk a shot. The elephant then moved away, squeaking occasionally a very high pitched note, and we followed cautiously for about 150 yards. Then again he stopped and I saw the same indistinct light mass, but felt sure now which end of it his head must be. Still it was not clear enough to take a definite aim and the rifle sights were almost indistinguishable. But it was to be now or never as a short distance more would have taken him into heavy grass jungle and so I fired, aiming as well as I could judge, high up the back behind the shoulder.

He went off into the jungle where for about a quarter of an hour we heard him breaking grass and small trees and squeaking as before.

As it would have been madness to follow him up, we had to leave him, but I knew that either I must have missed him clean in which case he was probably no more frightened of my gun than of villagers' guns which he must often have heard, or he was very badly hit and unable to go, had he been lightly hit only he would have gone straight off for miles.

Next morning my mahouts brought me word he was almost in the same place, so T. and I went out on a staunch pad elephant to investigate. We were followed at a distance by a crowd of villagers, and by a servant who was wildly anxious to come and who carried my 12-bore with lethal bullet for his own edification, though it would not have been of much use in case of trouble.

We found the elephant some 10 yards inside grass jungle. We were in a projecting patch of grass with a large ant-heap in front and as we were in it my servant pushed on in front by the ant-heap, which was some 25 yards from the edge of the jungle where the elephant was, across a piece of cultivated land. I could only see the top of the elephant's head and fired at what I judged must be his ear hole for a brain shot. He then turned out and charged across the open. My servant after trying for a moment to get behind the ant-heap wisely fled; I tried one frontal shot off my elephant (a *makna*) which stood well but not absolutely steady. This failed to stop the elephant and as I had only one cartridge left in the rifle I thought we had better retreat, which we did. My shot however turned him into the edge of the grass, where he stood giving me a steady side shot which dropped him. He was not such a big elephant as the former, but was a fine beast for all that, his forefoot measured 4′ 9½″ round and height at the shoulder between pegs 9′ 9″. His tusks were not long but weighed 56 lbs. the pair, and it is not often one has the luck to get two rogues of this size within four days.

G. N. SIMEON, I.F.S.

FORESTRY IN FRANCE.

II.—La Grande Forêt de Tronçais.

[By Professor E. P. Stebbing.]

After the French Revolution the Forest of Tronçais had suffered from all kinds of abuses, owing to the decline of all authority in the provinces. Under the 1779 plan another 20 years' supply of wood should be available for the iron works, whereas in effect only two—three years' supply existed, a glaring example of the improvidence which usually accompanies commercial undertakings when they are given a more or less free hand in exploiting the forests in their neighbourhood. The central reserve at this period practically formed the only forest of any value left. The inspecting officers drew up a set of recommendations for the improvement of the destroyed areas; but, as these were still subject to the 40-year lease, nothing was done. It was not till 1835 that the next measures were undertaken, followed by those of 1868, which are actually in force. The results observable to-day, which are the outcome of these measures, furnish remarkable lessons for us at home.

If one were asked to enunciate the principles of a true forestry policy in few words they could be expressed as continuity of working, a sound knowledge of forestry science in all its branches, and a wide administrative outlook. For the absence of any one of these will lead to mismanagement. Troncais and the Forest of Dean furnish many illustrations of the truth of these axims.

In a previous article it was shown that a great reserve was created in the central part of the forest which the east and west sections were destroyed to provide wood for the ironworks. It is proposed to glance briefly at the measures undertaken from 1835 onwards with the objects of restoring these areas.

Its Situation and Character.

The forest of Tronçais occupies an undulating plateau divided into three parts by the rivers Marmande and Sologne with a general trend northwards following the slope of the Bourbonnais plateau, the elevation varying from 700 to 1,200 feet. Several

knolls give the country a hilly aspect. In the south the plateau rests on the Primary and Archaic strata. To the north-west it lies on the more recent Lias beds, which stretch along the borders of the forest and are mostly under coppice forest in private ownership. These Lias beds are rich in fossils. The central part of the forest is underlain by the Trassic strata. These occur in large masses without any definite strata. and are red in colour from the decomposition of ferruginous clays and sandy loams. Outcrops of almost pure clay lead to the formation of spongy, ill-drained patches locally termed "terres boulaises." The manner of treating these forms a most instructive study for foresters. The impermeability of areas of pure clay account for the presence of several large natural lakes and artificial reservoirs in the district. This brief exposition of the topography and geology of the forest is necessary in order to arrive at an appreciation of the lines upon which the restoration work proceeded after 1835.

They have a pleasing custom in the French Forest Service of naming the "Rond-points" or meeting places of several roads in a forest after distinguished officers. Thus young forest officers and students working in the forests have ever before their minds the great examples of the past. Troncais is no exception, and the Edinburgh University forestry students, who spend over two months on a practical course in this forest and neighbourhood, became well acquainted with such names as Desjubert, du Guiny, and de Buffevent.

This year a new "Rond" was inaugurated, and given the name of a great French forester and silviculturist, Mons. R. Raffignon, who has spent forty years of his life in Tronçais. Edinburgh University had the great good fortune and honour to be invited to assist at this ceremony of the dedication of the "Rond Raffignon," the whole of the French Forest Staff and other dignitaries being present.

To come back to the forest. In the year 1832 its condition was as follows:—(1) 11,250 acres, including the reserve, in fairly good condition; (2) 10,000 acres ruined, and fit only for grazing; (3) 6,000 acres of blanks.

THE SCHEME OF ADMINISTRATION.

In 1835 a new working plan was framed by Monsieur de Buffevent. He prescribed the regeneration of the reserve, subject to a possibility by volume, in 60 years' improvement fellings in the east and west sections, and the reafforestation of blanks. A scheme of road construction and drainage was also prescribed. A network of some 200 kilometres of drainage ditches along the horizontal outcrops of clay was constructed. Regeneration was obtained, or attempted, in various ways. On areas of good soil near the outer boundaries of the forest, concessions were given for 4—6 years to neighbouring agriculturists. They were allowed to raise crops on the area granted, on condition that during the last year of the concessions they sowed the area up with acorns, the latter being supplied by the Forest Department. The areas so reafforested have produced some very fine oak pole woods which have since been mostly underplanted with beech. The same class of work was undertaken by the Department itself on areas situated within the forest, and too far from the outer boundary to make it possible for cultivators to take up concessions The poorer, dry, or wet soils were reafforested in part with maritime pine. The method of dealing with these tracts, of which we have extensive expanses of a similar nature at home, is very instructive. The Scots pine had, later on, to be substituted for the maritime. The success attending this work has been remarkable, and the crops produced were of inestimable value in the Great War, as the Americans, who left their trail across this countryside, could well vouch.

That the good work carried out on de Buffevent's plan bore fruit is evidenced by the survey made in 1868 by MM. Bernard and Buffault. This inspection showed a marked improvement in the areas under true growth, and in the condition of the forest generally, as follows:—(1) 17,500 acres of thriving crops; (2) 7,750 acres of mediocre woods; (3) 2,000 acres of blanks. The survey made by these two officers led them to form the conclusion that the forest was being called upon to yield a much higher output of first-class oak timber than the large proportion of younger age classes present warranted. A more conservative felling in

the old oak stands was recommended. A new working plan was accordingly prepared, and this plan with its revision made in 1898 is still in force. Under the provisions of the plan the forest was divided into six independent series, with a rotation of 144 years in three of them, and 180 years in the other three ; a subsequent modification applied the 180 years rotation to all the series or working sections. Each of the latter were divided into six periodic blocks, 30 years being allocated (on the 180 year rotation) to each block. The plan prescribed working by the uniform or shelter wood compartment system of successive regeneration fellings, artificial aid being only given to plant or sow up places which had failed to become naturally regenerated.

The Sorts of Timber Grown.

The period allowed to obtain a new crop of trees over the block being regenerated was, therefore, 30 years. The chief species are oak, beech and hornbeam, with subsidiary ones, such as birch, willow, poplar, etc., which are cut out early. The oak is outgrown by the hornbeam (up to sixtieth year) and beech (up to eightieth year), and therefore requires constant protection against them during these periods. The oak is also very sensitive to spring frosts, which are very severe here, lasting up to June. Briefly when a compartment of the forest comes up for regeneration, the undergrowth, consisting of holly, brambles, *Lonicera*, advance growth of beech, etc., is cleared off and a seeding felling made in the old crop. The new crop appears more or less unevenly over the area. Owing to the frost danger to the young oak, the overhead cover of the old trees must be maintained as long as it is required for their protection. The old trees are, therefore, removed in several secondary fellings, followed by the final cut, when shelter is no longer required. Frost level height varies in Troncais from three to (in frost holes) five metres; therefore, the crop must have grown above these levels before it can be exposed. The work entails expert knowledge, since the working plan is based on finance and the volume of oak timber to be removed annually is fixed. When a "lot" of old trees is sold to a contractor, under the contract, after the felling and removal of the timber, he has to make a cleaning in the

young crop on the particular area. This is done under the supervision of the forest guard, all damaged young trees being cut back, and young beech, hornbeam, etc., interfering with the oak being topped or cut back. These cleaning operations have to be repeated (by the department) at intervals until the crop has reached the young pole stage. From this time onwards thinnings are made in it every ten years. The thinnings are marked by the gazetted staff. They yield a good profit, since everything down to small fuel and faggots is saleable. A considerable amount of pitwood for the French collieries is obtained from the thinnings. Most of the beech and hornbeam will have been removed by about the hundredth year, and an understory of these species comes in naturally. This grows up and thus prevents the stems of the oak producing epicormic branches, to the detriment of the timber.

How the Oak is Used.

As to the uses to which this magnificent oak timber is put? To many they may prove more interesting than the method of growing it. In addition to naval requirements, furniture and veneers, its chief raison d'être is for the production of staves for brandy and wine casks. Good cognac is kept in the cask for a long period. The wood for these casks must be straight grained, free of even small knots, and of a high density. The oak trees are felled, sawn up into the desired lengths, and the latter are then split, on the spot, into sections (like dividing an orange), with the crudest looking, though very effective, tools by adepts at the art. The section is then split into staves, which are planed to the required thickness. Top and bottom pieces for the casks are also prepared. Neat piles of these staves are to be seen in the forest at the present time on the spots formerly occupied by the great trees. There is no waste, as the shavings and rejected pieces are used as kindling firewood and other purposes, and the larger the diameter of the tree the less the proportion of the latter.

At first sight it may appear a rather sinful use to put such a magnificent timber grown with such skill. But inquiry into this aspect of the matter brings to light a number of industries

dependent upon the material grown, involving a considerable number of skilled forest and other workers. In its ramifications one realises that the production of this timber is essential to one of the large trades of the country—the wine and spirit trade. And the origin of the industry goes back as already mentioned to Roman times when the old leather bottles was replaced by the cask.

It has been noted that only the straightest fibred timber can be used, and that the staves are fashioned by hand by highly skilled workmen. Attempts have been made to cut the staves with the circular saw, but so far as high grade casks are concerned they have failed. If the saw, as it will, cuts across the medullary rays the cask will ultimately leak ; such a risk cannot be incurred where high-priced wines and spirits are concerned.

It is a most alluring study, the utilisation of the fine Tronçais oak timber, as interesting in its way as the methods by which it is produced, and the latter entail the most scientific practice of the art of the forester.—[*The Scotsmans.*]

THE REGULATED SELECTION FOREST.

By Sir Wm. Schlich, K.C.I.E., F.R.S.

It is well-known that the bulk of the 1,100,000,000 acres of forests in the British Empire are worked, if at all, under a kind of selection system. Owing to the unsatisfactory results obtained in many cases in the past, the system has become discredited, so that in many of such forests in Europe the system has been changed into others, more particularly in the so-called Uniform system and its modifications, or into the system of clear cutting in high forest followed by artificial sowing or planting. The Uniform system has many advantages, as it provides a shelterwood for the protection of the new crop, and leads to more concentrated working, but if seed years do not come when they are wanted, or the seed does not produce a new crop, artificial regeneration must be done, which is likely to cause a good deal of expenditure. The clear cutting system may lead to satisfactory results where the rainfall is favourably distributed over the year

as it is in Great Britain, but where this is not the case the results may, and have been, disastrous. In many parts of the Empire droughts occur almost every year and in such cases clear cuttings should, in my opinion, be excluded. This has convinced a good many experienced foresters that, instead of abolishing the selection system, we should improve it, since that system provides permanent shelter to the soil and, if carried out in the right way, needs little or no outlay in the shape of sowing or planting. The latter point is of special importance at the present time owing to the high price of labour. These considerations have induced me to study the matter, and the following note is the outcome.

THE REGULATED SELECTION SYSTEM.

Description of the System.

Character of the System.—All size, or age, classes from one year old seedlings to the oldest classes are represented by single trees or small groups in all parts of the forest, and, theoretically, the work of selecting trees for cutting extends every year over the whole forest. In practice, however, the forest is divided into a number of blocks or compartments, which are taken in turn for treatment, so that the cuttings return to the same part of the forest after the lapse of a number of years called a "period." The size of the compartments and the length of the period depend on the intensity of management. The greater the latter, the smaller will be the compartment and the shorter the period. The natural regeneration of the forest is effected under the shelter of the old crop, especially where single trees or small groups have been removed. If natural regeneration fails here and there, artificial help is not excluded, though it is required only in exceptional cases.

The system secures at all times an equal protection of the soil, more especially as regards the preservation of a suitable degree of moisture. Protection is given not only from above, but there is also side shelter owing to the mixture of the several side classes in all parts of the forest. On sloping ground the rainfall is effectively retained; avalanches, the carrying away of fine earth, landslips, etc., are prevented or, at any rate, moderated.

As a consequence, protection forests situated in mountainous districts are usually managed under this system. All these matters act beneficially upon the producing factors of the locality, which is a substantial offset against any shortcomings of the system in other respects. Views differ somewhat regarding the extent to which selection forests are exposed to external dangers, as compared with the uniform shelterwood system. In the writer's opinion, the former is, on the whole, the more favourable, because only very small parts of the soil are at one time exposed to the injurious effects of the sun and air currents. Damage by frost and drought is smaller, and probably also that from wind and snow-break.

Owing to the conversion during the last century of considerable areas of selection forests into the uniform systems, comparative observations are somewhat scarce as regards the production of timber. These conversions are due to the belief that selection forests produce smaller quantities of wood than the Uniform system. It has, however, been recognised of late that this opinion was due to the fact that many selection forests were not managed as efficiently as should have been the case. At any rate, there are now some selection forests which, owing to careful and rational management, are equal, if not superior, to the uniform system. Young growth, no doubt, develops slowly, as it is much kept back by the older trees, but this is made good by more active development when it has reached the full enjoyment of light and the benefit of more favourable moisture conditions, secured by the continuous protection of the soil. There can be no doubt that in many cases the boles of the trees produced under the selection system are less clean of low branches than those grown under the uniform system; some species are also liable to suffer somewhat in height growth. These are serious shortcomings. On the other hand, the system is well adapted for the production of trees with a large diameter, as they can be left in the forest for any length of time.

THE MANAGEMENT OF THE SELECTION FOREST.

The successful treatment of the selection forest makes great demands on the forester. To obtain really good results, it is

essential that he should have a detailed knowledge of all parts of the forest, since he has so to say, to guide each tree throughout all stages of its life. All depends on his personal judgment in the selection of the trees to be left for further development, and of those to be cut, and when to be removed. It follows that the forester must be given great freedom of action, and yet his measures must fit into the framework of a general scheme of management, whenever a sustained yield is aimed at. Given a competent manager, all will be well, but, failing that, great mischief may be done ; hence control is essential. There has been an outcry of late against all kinds of control of the local managers. It has been said : Away with all systems, away with rotation and what not, full and free liberty to the local manager ! These are wild ideas, which are not followed in other branches of human activity, and they are certainly out of place in forestry, where forethought for future requirements during long periods of time is essential.

The details of a general working scheme depend on local conditions, but its main features must be laid down and observed. More especially the determination and regulation of the future yield must be settled by authority and not left to the personal ideas of the local manager. The following scheme may serve as an illustration :—

Determination and Regulation of the Yield.—The first important measure is to divide the forest into a suitable number of compartments. The size of these depends on the total area of the forest and on the intensity of management. Where the latter is well advanced, the compartments should be small. In the case of extensive areas and where the management is as yet of small or moderate intensity, it may be desirable to arrange the compartments into two or more working sections. The compartments in each working section should be consecutively numbered ; that is to say, one series of numbers for each working section, if not for the whole forest.

Each compartment should be treated on its own merits, with due reference to the yield of the whole working section. If by

careful treatment each compartment is gradually brought to its highest possible production, all must be well in the whole forest.

The next measure should be to ascertain the exact condition of each compartment, and from that date to keep a separate account for each unit of division of all measures taken, and acts done within its boundaries. The establishment of sub-compartments should be reduced to a minimum. It there are differences of a temporary nature in a compartment, they will naturally disappear in course of time. If they are likely to remain permanently, it is much better to establish at once two compartments instead of one.

With a view to determining the yield capacity of each compartment and to lay down its further treatment, the growing stock must be carefully measured and classified. The latter process may differ in accordance with local conditions, but generally it would be done in the following way :—All trees down to a minimum diameter (or girth) would be carefully measured and their volume ascertained. These trees and their volume would be divided into several size classes ; in some cases into large trees, medium sized, and small trees ; in other cases more definite limits would be adopted. For instance : Let the minimum diameter at height of chest be 6 inches (or 20 inches girth) and each class with a range of 6 inches, there would be the following classes : First class, 6 to 12 inches ; second class, 12 to 18 inches ; third class, 18 to 24 inches ; fourth class, 24 to 30 inches, and so on. By numbering in this way, from the smallest class upwards, the number of each class indicates at once its limits, which is not the case by numbering from the largest class downwards. All young growth below 6 inches diameter is examined, so as to ascertain whether it is of sufficient quality to provide the required number of saplings to replace the larger trees which will be removed from, time to time ; if not, cultural measures are indicated.

Throughout all stages of treatment the yield must be intimately connected with the increment. The one must be equal to the other if the proportion between the classes is such that the objects of the proprietor can be indefinitely realised ; in other words, if the growing stock is normal. If there is a deficiency or

surplus of growing stock, less than the increment in the first case and more in the other case, should be cut for some time, until the normal condition is established. It is not possible to define the normal state of the growing stock by a formula as can be done in some other systems; it can only be described as that which yields permanently the greatest return of the class of timber desired by the proprietor. The normal state can be reached only gradually in the course of one or more periods, during which the forester establishes the proper proportion between the number of trees in the several classes, which should always consist of the most vigorous promising trees. Their number should be so that each tree is given enough growing space required for full development and no more, according to the size class to which it belongs, provided that the light required for the proper development of the young growth under 6 inches is given. For the rest, a full stocking of the area should be aimed at, so as to obtain a full return, and to produce as clean and well-shaped boles as may be possible under existing conditions.

The difficulty is to ascertain the increment which may be expected during the first period. An effort may be made to determine it by examining the increment laid on in the immediate past and adopting that for the immediate future, until more reliable data becomes available. The latter can be obtained only by re-measurements after short intervals, five or ten years. Let be the volume in the beginning $= V_1$, that after n years $= V_n$, and the Volume removed during the n years $= Y$, then the increment during the n years amounts to:

$$I = V_n + Y - V_1.$$

In this way the increment of each class, as well as the increment of the whole compartment during the first period can be ascertained. With every succeeding periodic measurement the determination of *the increment becomes more and more accurate. In* cases where the degree of intensity is very high, the investigation of the increment may be extended to single trees.

The procedure may be further illustrated by a small example:—Given a selection forest of 300 acres, such as a landed proprietor in Great Britain might possess, and assuming that it

has been divided into ten compartments of an average area of 30 acres each. Taking a typical compartment, it was found to contain a young growth, below 6 inches diameter at height of chest, fit to furnish the several classes above 6 inches with a sufficient number of recruits. These classes contained at starting the stock of trees per acre and their volume given in columns b, c and d of the subjoined table :—

TABLE SHOWING THE DETERMINATION OF THE INCREMENT.

Limits of Classes. Diameter, Inches.	Growing Stock at Start.			Growing Stock after 10 years and increment.					
	No. of Trees.	Vol. per Tree c.f.	Total Vol. c.f.	No of Trees	Vol. f.	Vol. of cut Trees c f.	Total Vol. c.f.	Deduct first Vol.	Increment in 10 years.
a	b	c	d	e	f	g	h	i	j
I. 6—12 ...	90	10	900	90	900	200	1,100	900	200
II. 12—18 ...	40	25	1,000	41	1,025	400	1,425	1,000	425
III. 18—24 ...	15	60	900	21	1,260	120	1,380	900	480
IV. Over 24 ...	5	140	700	9	1,260	140	1,400	700	700
Total ...	150		3,500	16	4,445	860	5,305	3,500	1,805

There were at starting 150 trees over 6 inches diameter with a volume of 3,500 cubic feet, divided into the four classes as given in column b.

At the end of ten years the growing stock was re-measured for the purpose of obtaining the necessary data for the determination of the periodic increment. As it was not desirable to suspend cuttings during the first period, nor to overcut the compartment, the forester made the best estimate he could of the probable increment during the first ten years. He fixed it, after an examination of selected test trees, at 1,160 cubic feet. In consideration of the fact that the two older classes contained only 1,600 cubic feet, against 1,900 in the two younger classes, he decided to cut less

than the estimated increment, so as to increase the number of trees and the volume in the older classes in accordance with the objects of the proprietor. The amount actually cut during the first ten years amounted to 860 cubic feet. In this way the number of trees in the two oldest classes was raised from 20 to 30. Whether a further augmentation in the same direction is desirable will depend on further experience.

The results of the re-measurement are shown in columns e to j of the above table The increment laid on during the first period amounted to 1,805 cubic feet per acre, equal to 180 cubic feet per acre and year, which has been fixed as the maximum yield during the second period of ten years. The same procedure is followed in the other nine compartments, one being taken in hand in each year. In the eleventh year operations return to the compartment taken first in hand. Assuming that the compart ment dealt with above represents an average of the ten compartments, the total average annual increment on the 300 acres would be equal to 54,000 cubic feet, which amount could be cut annually.

The area of the example is small, but similar results have been obtained by the adoption of the system on much larger areas, as, for instance, in the Oberwolfach Communal forest in the Black Forest, in Neuchatel in Switzerland, and in places in the Jura Mountains.

Foresters will be well advised to pay careful attention to the system. It certainly gives better results than the coppice with standards system as practised in Britain. It should be the recognised system in most of the colonies for many years to come, especially where long spells of drought are the rule and not the exception. No doubt many of the trees are liable to be somewhat more branchy on the lower part of the boles as compared with the uniform system, but that drawback can be met by pruning while the trees are still young. The pruning should be done in instalments beginning with the lower 10 or 12 feet at a comparatively early age, and carrying the operation upwards some years afterwards. By restricting the pruning to those selected trees which are destined to reach the older classes, the expense of the operation would be very small.

The system is applicable to all shade-bearing and moderately shade-bearing species. It is less suitable to light-demanding species, because they would have to be given so much growing space that the protection of the soil and the preservation of a suitable degree of moisture would be seriously reduced.—[*Empire Forestry Journal, April* 1923.]

RE-AFFORESTATION IN KENYA COLONY BY MEANS OF SHIFTING CULTIVATION.

By H. M. Gardner,

Assistant Conservator of Forests.

In his recently published report, Professor Troup states that he considers the Forest Department is to be congratulated on the efficiency and cheapness with which the planting work is being done in Kenya Colony. A brief description of the methods employed may be of interest to foresters in countries similarly situated.

Advantage is taken of the native's system of shifting cultivation. The system is of course practiced by uncivilised tribes in many countries and the following is merely a description of how it is turned to account in Kenya.

In Kenya there are no real forest tribes. The forests are uninhabited except for a few Wandorobo who exist entirely by hunting, living a wandering life not in settled communities and in numbers certainly not reaching one per square mile. There are other tribes, however, notably the Wakikuyu who are great cultivators and are very willing to come and live in the forest where they get rich forest soil for their crops and plenty of free fuel, which latter is very scarce and expensive in their own reserves.

The admission of native squatters into the forest is controlled by the Resident Natives Ordinance which applies equally to farms and forest reserves. Under this Ordinance only such number of native families are allowed to reside on a farm as is permitted by a magistrate after due enquiry into the labour

requirements of the farm, it being compulsory under the Ordinance for each adult male squatter to do 180 days work in the year for the owner at the rate of pay stated in the agreement. In return the owner has to provide sufficient ground for the native's own cultivation and grazing for his stock. For forest squatters a clause is added that the squatter must cultivate only such land as is marked out for him, must keep his *shamba* (*i.e.*, field) clean, and must tend any trees planted in the *shamba* until such time as by reason of the growth of the trees it is no longer possible for him to plant crops in the *shamba*.

The aim of the Department is to have at least 200 families of squatters in each forester's district, but in some districts owing to ill-informed opposition by the European settlers it is difficult to induce the magistrate to grant a permit for so many, and in these districts planting is still in a backward state. There are only two large cultivating tribes that are as yet of much account in the labour market, these being the Wakikuyu and the Kavirondo. They are both equally good cultivators and workers but whereas the Wakikuyu brings his family and makes his home wherever he goes, the Kavirondo only leaves his reserve for the purpose of earning money. He will not settle down and make a home outside his reserve and rarely brings his family with him and is therefore of no value in the Department's planting schemes. Fortunately the Wakikuyu of recent years have shown great keenness to leave their reserves and willingness to penetrate and settle anywhere even in the remote parts of the Colony if they can get good land to cultivate there.

When a native applies to be taken on as a squatter he is, if the quota for the district is not yet complete, sent before a magistrate to sign the agreement under the Ordinance. He is then shown where to build his hut, usually in the nearest grass glade to the area that is to be planted, and the piece of ground that he is to cultivate is marked out for him. The squatters are grouped together in two or three locations at points conveniently situated with regard to present and future planting sites and areas of bush or grass are set aside for the grazing of their stock. Great opposition is often manifested by settlers and others to the

admission of native squatters into the forests, on the grounds that once in the forest they become hidden, are under no control, afford a harbourage for all the bad characters in the locality, and are very liable to live by thieving from neighbouring farms, all of which allegations though persistently affirmed are entirely unfounded. Particular care is taken to see that all squatters are grouped in compact locations in places readily accessible for supervision, that no strangers take up their abode in them and that all lazy or doubtful characters are weeded out and sent back to the reserves.

The area to be planted is usually bush where the forest has been clear-felled for timber or railway fuel, or has been burnt out or otherwise destroyed. Each squatter is given on the average, about 2 acres, the area depending on the number of his womenfolk. It is a mistake to give large areas as, though the native will probably ask for more and clear it, yet experience shows that 2 acres is about the maximum that he can keep clean. The man clears the bush and plants his crops, usually a thorough mixture of maize beans, peas and potatoes. Eighteen months after the ground is given out, it is planted by departmental labour with young trees usually 1-year-old nursery transplants. The squatter continues to keep the *shamba* clean and to plant crops between the trees for at least another 12 months, by which time the trees are too big to be affected by any weeds except climbers. During this year the squatter is given another 2 acres of ground to break up, which will be planted with trees 18 months later, and so the work goes on. With 200 families of squatters an average of 200 acres a year can be planted up with trees.

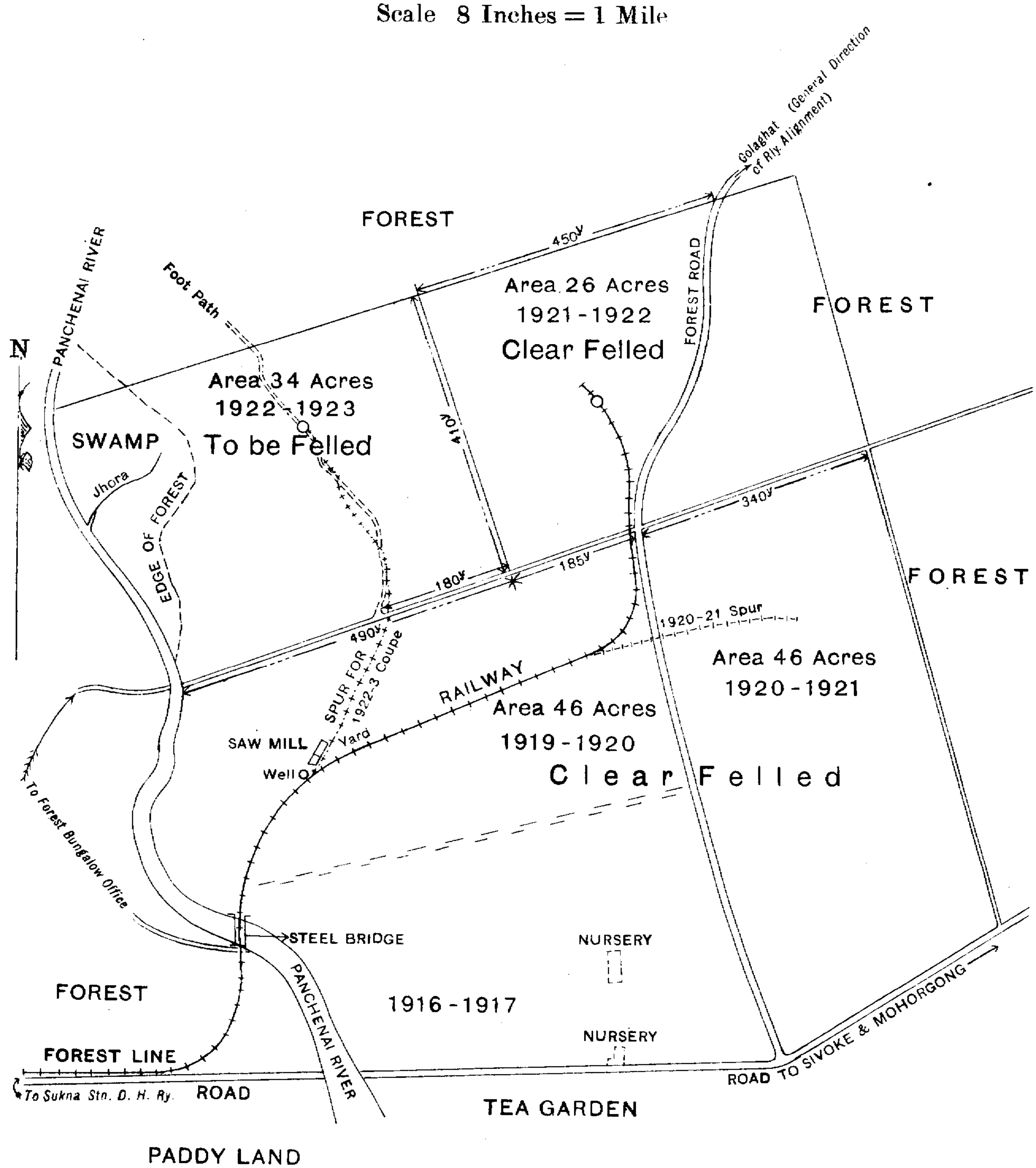
The departmental labour for all purposes is drawn from among the squatters who turn out for work when called upon up to a maximum of 180 days in the year. They are paid when at work the local rates of wages, usually 10*s*. per mensem. In the formation of plantations the only expense to the Department besides the raising of the trees (which is about 8*s*. per acre), is the cost of staking out and pitting the ground and planting the trees. This cost is not more than £1 per acre and usually less. There is also the cost of creeper cutting, till a close canopy is formed. It is estimated that the total cost of formation and maintenance of

plantations until thinnings begin, including forester's salary and proportion of head office expenses, is about £3 10*s.* 0*d.* per acre. If squatters are not available and the ground has to be cleared and plantations kept clean by departmental labour the cost is almost exactly double.

The system has many advantages besides the cheap cost of planting, the most obvious being the insurance of a steady supply of labour and an ample reserve which can be called out at short notice at critical periods such as the planting season or in emergencies such as forest fires. It would seem that the system could profitably be introduced into all Colonies with similar native populations, but indeed it is so simple and its advantages are so obvious that it is probably more widely spread than the present writer is aware of. It does, however, presuppose a population with an unsatisfied land hunger or a "wanderlust," and it is possible that Kenya is exceptionally fortunate in the posession of Wakikuyu the tribe to whose needs the system seem to be as admirably suited as it is to those of the Forest Department.—[*Empire Forestry Journal, April* 1923.]

MAP OF SUKNA OPERATIONS.

Scale 8 Inches = 1 Mile



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FOREST OPERATIONS AT SUKNA, KURSEONG DIVISION, BENGAL.

INTRODUCTION.

Our object in publishing this account of the exploitation and re-stocking work at Sukna is to show the possibilities of using mechanical methods for extraction and conversion on a sufficiently small scale to enable the *taungya* work to be satisfactorily carried out.

The idea has existed that for a sawmill to be commercially successful, it must be of large capacity to justify the employment of skilled labour (sawyers, filers, etc. and therefore the supply of logs must likewise be large, usually larger than can be arranged for in most of our Indian forests on a silviculturally sound basis This idea which has resulted in a certain amount of antagonism being felt between the mechanical and the silvicultural enthusiasts among us.

The aim at Sukna is to balance the exploitation and the silvicultural sides of the operations so that the restocking by *taungya* keeps pace with the extraction and conversion plant working up to its economic capacity.

This balancing feat is not so simple as it seems, for the same very small labour force has to work both branches but it has been possible to do so quite conveniently in the following manner, the softwoods, readily liable to insect and rot damage, are sawn up as soon as felled and converted into timber and planking during the cold weather months,—October to the end of March ;

the hardwood, sal—not readily subject to decay and insect damage is skidded in from the coupe to form a large dump at the railway siding during the cold weather; in April and May the whole of the labour force has been turned on to the restocking work.

In the rains proper, the skidder crew is employed in loading and despatching the sal logs in railway cars and the sawmill is used for sawing up these logs into timber and planking.

A small mill such as at Sukna of American manufacture with an English portable steam engine can be had for just under Rs. 20,000 F. O. R. Calcutta and when once the labour has been shewn how to operate the various machines, very little skilled supervision is needed.

The inserted tooth saw saves the need of employing a skilled saw fitter and filer, whilst by adopting a good water spraying arrangement on the large main saws, the danger from overheating and loss of "temper" is largely minimised. The mill at Sukna has now been running since last October, save for a break of two months during the busy planting months of April and May with a crew consisting wholly of forest villagers under locally recruited carpenter-mistri. The skidder, fitted with a rehaul line, has been run entirely by these forest villagers.

A form of stump jumping plough has been designed and is being constructed to be worked by the skidder, by which means it is hoped to avoid the labour shortage during the restocking period and also to enable the yearly coupes to be increased in size for the areas are at present limited by the amount of labour available for this planting work. Even with the existing size of coupes, however, the results obtained during the past year are regarded as satisfactory from both the mechanical and the silvicultural points of view.

PART I.—LUMBERING AND EXPLOITATION WORK.

General.

The objects of the experiments at Sukna are to determine whether in small clear-felled areas of from 30 to 80 acres

mechanical methods of extraction and conversion of forest produce on American lines are more profitable and satisfactory than the existing hand sawing and bullock cart transport, and, further what type of machinery and plant is best suited for such work.

The area in which the experiments are being carried out is the clear-felling coupe of the Sukna Sal Working Circle, where the prescribed annual area is 50 acres.

This district is typical of the comparatively flat foothill forests of Bengal ; on account of the climate, labour is scarce and difficult to retain throughout the year, so that the successful use of labour saving machinery and devices will enable a large percentage of forest produce, which would otherwise have a very small market value to be utilised and to provide a source of revenue to the Department.

By the concentration of work into areas for clear-felling many advantages arise, one of the most important being the ability to construct a proper means of communication (here a railway line) from forest areas, which would otherwise be regarded as practically inaccessible, to markets for forest produce.

General layout at Sukna.—The general layout at Sukna consists of :—

1. A railway spur from the main D. H. Rly. line at Sukna station and extending at present into the forest just one mile.
2. An improvised skidding machine, *i.e.*, a machine for hauling in the logs from the tree stumps to the railway line, where it there loads them on to log cars, specially built for this work.
3. A small semi-portable sawmill, of American manufacture and plan, set up alongside the railway line, where it is fed with softwood logs for conversion into tea-box, planking and shooks during the cold weather and for small sal log sawing during the rains.

The Railway.—The railway line has been laid and is maintained and extended where necessary by the railway company

free of charge to the Forest Department in consideration of the freight earned on the carriage of—

(*a*) sal logs to Siliguri.

(*b*) box planking for tea gardens mostly on the hill section of the railway and around Kurseong.

(*c*) fuelwood likewise for tea gardens mostly in the hills.

The Skidder.—The machine purchased for the hauling in of sal logs from tree stumps to the railway line, where they are loaded on to railway log cars, is an old single drum and single cylinder pile driver, and for many mechanical reasons has not enabled the full advangates of mechanical methods of extraction to be demonstrated, but it has nevertheless shown the following results :—

(*a*) *The uncertainty of supply of bullock carts is overcome* (moreover the carts available in this district would be insufficient for the removal of the produce from such an area as at Sukna).

(*b*) *A saving of from annas 1 to 1·5 per c ft. of sal sent by* rail, compared with bullock cart rates

(*c*) Much larger logs can be handled by machinery than is possible by hand and bullock cart giving an enhanced value to the timber of from 8 to 12 annas per c.ft.

In 1923, 34,000 c.ft. or 1,060 tons of sal timber will be sent to Siliguri. Thus, Rs. 20,000 will be saved on freight, whilst the enhanced value of the timber will be about Rs. 17,000.

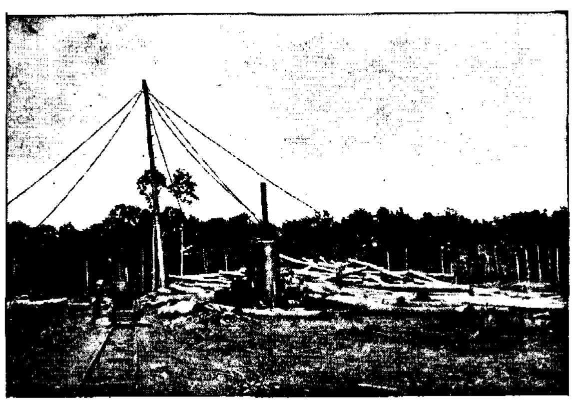
The Sawmill.—The small American sawmill was purchased in 1920, for the manufacture of tea-box planking from the soft wood logs felled in the Sukna coupes.

A short trial run was made towards the end of the hot weather in 1922 to determine what additional machinery was necessary to enable the plant to run efficiently and economically.

The whole of this machinery did not reach India from America before 1923, but sawing operations were commenced in November 1922 and have been continuous, save during the

1. Interior of sawmill—sawing up *simal* logs.

2. General view of the felled area 1922-23, showing the skidder moving itself into position.



3. General view of the skidder, at work by the railway line.

4. Sal log 32 feet long, weighing over 3 tons.

installation of the new machinery, which necessitated altering the layout of the mill considerably.. From November till the middle of March 1,50,000 s. ft. of half inch tea-box planking have been sawn. With the installation of the new machinery, the daily output has increased whilst the crew and consequently the cost sawing has been considerably reduced. The present arrangement is regarded as fairly suited for such localities and conditions.

The Crew at present consists of :—

			Rs.	P.M.
1	*Mistri* (part-time with skidder 2/3rds debited to mill) ...	on	50	„
1	engine driver ...	„	25	„
1	water pump man ...	„	15	„
1	main sawyer ...	„	16	„
1	edger sawyer ...	„	15	„
1	trimmer sawyer ...	„	15	„
1	scaler and take-off man	„	15	„
1	yardman stacking planks.	„	15	„
1	boy stacking, etc. ...	„	9	„

The monthly wage bill is Rs. 158-5-0 and the daily wage bil is Rs. 5-4-0.

The following figures give the output from March 1st to 23rd :—

1.	1,795	s.ft.	Actual days sawing ...	17·5
	1,260	s.ft.	Holidays and fire work ...	2·5
	1,440	s.ft.		
	1,404	s.ft.		
	530	s.ft. (crew on fire work.)	Bazaar days... ...	3·0
	1,840	s.ft.		
	1,360	s.ft.		
	3,000	s.ft.		
	1,180	s.ft.		
	1,374	s.ft.		
	1,888	s.ft.		

250 s.ft. (crew on fire
1,830 s.ft. work).
1,780 s.ft.
1.940 s.ft.
1,822 s.ft.
1,326 s.ft.
1,520 s.ft.

27,530 sft.

The average output during 23 days was 1,200 s.ft. a day, and the average output for 17·5 sawing days was 1,570 s.ft. a day.

Cost of sawing by the Sawmill.—The total cost of the plant in use at present amounts to Rs. 13,100.

Allowing a depreciation of 12½ per cent. per annum for the whole mill and Rs. 360 per annum for repairs, and also, that the output from the mill averages 1,200 s.ft. per diem of softwood box planking (and an equivalent figure when sawing salwood), the cost of sawing is made up as follows :—

Item—	per 1,000 s.ft. Rs.	a.	p.
Depreciation charges a 12 1/2 per cent. ...	3	12	0
Repairs at Rs. 360 per annum ...	0	14	0
Labour at Rs. 5-4-0 a day	4	6	0
Loading, planking into cars	0	4	0
Fuelwood for engine from coupe ...	0	14	0
Felling, dressing and carting at as. 2 per c.ft. of log and allowing 50 per cent. wastage.	10	6	0
Royalty at as. 3 per c.ft. log, ditto ...	15	9	0
Total cost ...	36	1	0
Average selling price ...	41	0	0
Profit to the Department per 1,000 s.ft. planking ...	4	15	0

Handsawing at Sukna is expensive and there would be an insufficient number of sawyers to convert the whole of the softwood felled each year into planking to give it its full market value. Owing to the high rates for handsawing, what softwood is converted into planking yields no profit nor is the full royalty value of the timber realised to the Department.

The sawmill converts the whole of the softwood timber felled each year in the coupes and not only enables the full royalty value of the timber to be realised, but also yields a profit of practically Rs. 5 per 1,000 s.ft. of planking sold, as it is being run at present.

Otherwise expressed, by selling softwood in the form of planking four annas are obtained for every c.ft. of log instead of three annas by selling it in the log.

1923 Season.

175,000 s.ft. of box planking will be sawn altogether this year.
100,000 s.ft. was sawn before mill was completely reorganised.
75,000 s.ft. will be sawn at a profit of Rs. 375.
100,000 s.ft. first sawn, only enabled royalty values to be realised.

Revenue from this year's working is therefore—

		Rs.
Royalty only on 100,000 s.ft.	...	... 1,556
Royalty only on 75,000 s.ft.	...	... 1,160
Profit, clear, on 75,000 s.ft.	...	... 375
Total for the Season	...	... 3,091

(The mill will be turned on to sal log sawing, when the softwood supply is finished.)

Fuelwood.—The fuelwood is prepared from branches, tops and débris in the coupes and is sent in long open bogie cars, containing 850 c.ft., to tea gardens mostly in the hill section of the railway round Kurseong. As with tea-box planking, the demand for firewood is greater than the supplies available from the Sukna coupes.

The profit resulting from the sale of firewood in railway cars from the forest is shown by the following figures:—

	per 100 stacked c.ft.		
	Rs.	a.	p.
Cutting and stacking at as. 10 per 60 c.ft. ...	1	0	8
Carting to railway line as. 4 per 60 c.ft. ...	0	6	8
Loading on to cars at Re. 1/8 a car ...	0	3	4
Royalty per 100 c.ft.	1	8	0
Add 10 per cent. wastage and closer tacking ...	0	3	10
Totals ...	3	6	6
Price realised at Rs. 36 per car of 850 c.ft. .	4	3	9
Revenue over and above royalty per 100 c.ft. ...	0	13	3

1923 Season at Sukna.—137,330 c.ft. (stacked) is being sold this year.

	Rs.
Royalty value realised	2,060
Clear profit realised	1,137
Total revenue from fuelwood ...	3,197

Comparison of revenue derived per acre in sal and in softwood forests from sal, box planking and fuelwood by private agency and by Departmental operations.

Item.	Sal forest		Softwood forest.	
	Private agency.	F. Dept.	Private Agency.	F. Dept.
	Rs. a. p.	Rs. a. p	Rs. a. p	Rs a. p.
Fuel per 100 c.ft. ...	1 8 0	2 5 3	1 0 0	2 5 3
Fuel per acre ...	60 10 0	97 0 0	36 0 0	84 0 0
Box planking wood per c ft.	0 3 0	0 4 0	0 3 0	0 4 0
Box planking wood per acre.	22 4 0	29 8 0	33 0 0	44 0 0

ITEM.	SAL FOREST.		SOFTWOOD FOREST.	
	Private agency.	F. Dept.	Private Agency.	F. Dept.
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
Sal trees (3′ girth and over) 3—4′ ...	47 8 0	35 0 0	...	...
4—5′ ...	97 0 0	148 8 0	...	...
5—6′ ...	200 0 0	430 8 0	...	...
6—7′ ...	275 0 0	395 0 0	...	...
Over 7′ ...	42 8 0	147 0 0	...	...
Sal trees per acre ...	662 0 0	1,156 0 0	...	...
Total per Acre...	745 0 0	1,282 8 0	69 0 0	128 0 0

E. O. SHEBBEARE, I.F.S.,
and
G. W. HOULDING,
Forest Engineer.

[*To be continued.*]

FOREST VILLAGES IN BURMA.

The title derives its inspiration from two very interesting articles on forest villages which have appeared recently in the *Indian Forester*, one from Assam in November 1922 and one from Bombay in March 1923. The title is a little misleading however since this article is only concerned with those villages which are situated in the Tharrawaddy Forest Division in Lower Burma. I often wonder what picture the word Tharrawaddy conjures up in the minds of forest men in India. To many it probably conveys nothing except perhaps a memory of the beginning of things when Brandis and Schlich passed this way and left their mark. To certain others who have visited here I know it must convey a vision of bungalows built in the air on vast posts of *pyinkado* and connected by interminable roads made of unfathomable mud. All this sounds rather like self advertisement, but why should we not advertise our Divisions.

This is the age of propaganda, the age of exchange of Notes. There are names of places in India that always rouse my curiosity which has generally to remain unsatisfied. Nilambur—How does the Divisional Officer set about forming and establishing those serried and perfectly even rows of teak of which we hear so much? And what happened to him in the Moplah rebellion? He never told us. Then Kashmir—Is there really an I. F. S. man there and how does one get the job? Does he go to his work by camel or by house-boat? Changa Manga—Ah, I know all about Changa Manga because I have been there. It consists of millions of mosquitoes which don't bite you and funny old lumbering *nilgai* which get chased by your fox terrier. There is also or was a light railway which brings the timber and firewood out to the main line and by which you return in the empty trucks to the bungalow built of stone which is in the heart of the forest. Then I have heard tell of a Division in the C. P. or is it the U. P. where you do your thinnings by motor car and there are curtains in the rest-houses. I may be told that all this information is available in departmental blue books, but I don't like blue books. The *Indian Forester* is a much more interesting place in which to read about these things.

We are not getting on, however, with our forest villages. These villages were started in Tharrawaddy in 1918 for the purpose of providing permanent labour with which to carry out the programme of concentrated regeneration prescribed in the Working Plan for the hill forests. To-day there are seventeen villages distributed over the various felling series that go to make up the regeneration block. The forest villages are of two kinds—the *taungya* village which does the sowing and planting of the forest crop in conjunction with its *taungya* cultivation, and the coolie village which carries out weeding in the young regenerated areas and does various other forest works.

The *taungya* village is situated usually in the middle or on the edge of the compartment which it is going to help to regenerate. The houses are built of bamboo with hardwood posts and thatch roofing. The villagers get their building materials free, and in

return we make them put up substantial houses where they will be comfortable and well protected from the weather. The villagers elect their own headman who has much the same powers as a headman of an ordinary village. He receives a monthly pay from the forest department at the rate of eight annas per household up to a maximum of fifteen rupees. No difficulty is experienced in recruiting *taungya* villagers. The highest ambition of most Burmans in this district is to have a plot of permanent cultivation of their own, but failing that they like to have land on which they can make *taungyas*. This we can offer them and we throw in the additional attractions of exemption from taxes, free forest produce for domestic use and payment for growing our trees for us.

The type of forest with which we are dealing is either moist or dry deciduous forest of mixed species with bamboo. The annual coupe is exploited partly through departmental agency which removes all the teak ; the right to extract the other species is sold by auction to local timber traders who in addition to their bid at the auction pay royalty on the timber extracted. When extraction is completed the coupe still contains numbers of small unmarketable trees and numerous clumps of bamboo. This is where the *taungya* villager comes in. In the February following the completion of exploitation the village clear fells the coupe. The bamboos are felled first and then the trees are felled on top of them. One villager or rather one household can generally tackle four acres successfully. Towards the middle of April the felled débris is set fire to and disappears almost entirely in a fierce conflagration. During the early showers that fall between the date of the fire and sowing time, a good deal of weed growth springs up on the bare surface of the *taungya* and the villager has to make a complete weeding before starting cultivation. During this period he stakes out his area with bamboo stakes at the spacing required. The procedure at this point varies according to the species to be grown. By far the greater portion of the area is regenerated with teak, but in localities which do not produce good teak and which are better suited to other valuable species, these species—generally *pyinkado (Xylia dolabriformis)* or *Terminalia tomentosa* in this

Working Circle—are used. In the case of teak, the seed is broadcasted by the villager on a flattish, well drained spot in his *taungya* a few days after the fire so as to form a rough nursery. He then goes on with his staking 6′ × 6′ and his weeding, and by the beginning of June when the rains are setting in, in earnest, he finds that his teak seed has germinated and proceeds to transplant the most vigorous seedlings to the lines. By this means he is sure of getting a strong young plant at each stake. *Pyinkado* and *Terminalia* seeds are delicate and have to be sown direct at stake when the rains have begun but as they germinate very quickly, they soon catch up with the teak seedlings.

The next operation is the sowing of the paddy. This is generally made the occasion of a certain amount of hilarity as the whole village gathers together and does each holding in turn. The young men go in front each armed with a spring bamboo pole about twelve feet long and fitted with an iron grubber. With these instruments they nick little pits with great rapidity in the earth as they go along in line, the pits being about nine inches apart. Behind them come the young ladies with small baskets of paddy from which they drop about a dozen seeds into each pit. They do not cover the seeds with earth as this is done for them by the first shower of rain. Once his paddy is sown the villager is able to sit back and take his ease for a time. From sowing time to harvest he forsakes his house in the village for a small hut erected in his *taungya* and here he spends the rains watching the growth of his paddy, and also we hope, of the tree seedlings. About the middle of January after his paddy has been reaped the young seedlings are counted, and he receives his reward at the rate of eight annas per hundred live plants.

The coolie village is a more difficult problem. Casual labour, in increasingly small quantities nowadays, can be obtained for forest work only at certain times of the year, and during the early part of the rains when the young plantations have to be weeded it is not available at all, as the whole of the local population is then occupied with permanent cultivation. It has therefore been necessary to establish at each centre of operation a village for labour only. These coolie villages cannot be given land for cultivation

as this would occupy them at a time when they are required for weeding. We do however allow them a little land round the village and encourage them to make vegetable and fruit gardens thereon. These add a little to the family income and can be attended to by the women and children. During the rains the men are fully occupied with the weeding, filling in of blanks and making of inspection paths in the young regenerated areas. Towards the end of the rains and after all weedings are finished they go on to cleanings and thinnings in the old teak plantations. In the cold weather they are engaged on the girdling of teak and marking of the new coupes, upkeep of roads and paths and repair of boundaries ; then they clear the fire lines and in the hot weather they become fire guards. These villagers get the same concessions as *taungya* villagers as regards freedom from taxation. They are collected chiefly from among the poorest of the local inhabitants, but the cost of living is now so high in Burma that in order to induce them to remain in the forests we have to pay up to as much as one rupee a day for rains work.

Without a more or less permanent labour force of this kind it would be impossible nowadays to get through the programme of work. As it is, Burman labour cannot be relied on for earth work, and for road making it has been the custom for several years now to import labour from the Hazaribagh district. The establishment of these coolie villages has solved our labour problem for the time being, but with the ever increasing size of our area under concentrated regeneration it is certainly a problem that will be always with us in Burma.

A. P. DAVIS, I.F.S.

THE STUDY OF A PRIMITIVE COUNTRY AND ITS PEOPLE— BEING A SHORT ACCOUNT OF THE PAWRAS AND BHILS OF THE AKRANI PARGANA, WEST KHANDESH DISTRICT, BOMBAY.

(*Continuation.*)

Marriage.—Pawras and Bhils generally have one wife only, but sometimes 2, and rarely 3, 4 or 5 according to wealth. Remarriage of widows is permitted. Polyandry is unknown.

It is customary for the father of a boy to seek his first wife for him after he has attained maturity. Girls are generally married at the age of 15 to 20. A girl is supposed to be the property of her father and he has every right to dispose of her in marriage to any member of his community, and naturally tries to realise the largest amount he can. A Pawra father will demand from Rs. 200 to Rs. 300 for his daughter, and a Bhil father from Rs. 25 to Rs. 100. This sum is called *dejo* and the exact amount is settled before a *panch* so as to become binding on all parties. This *dejo* may be paid in one sum or by instalments, and in cash or in kind, *e.g.*, bullocks, etc. Ordinarily the girl is not allowed by her father to go to her husband's house until the major part of the *dejo* is paid, but when a son-in-law is very poor the girl's father may consent to allow him to pay the *dejo* in the form of service. In which case the son-in-law works without wages for his father-in-law for 3 or 4 years and is known as a *khandadia.*

Frequently a time limit is fixed for full payment of the *dejo.* In case of default the father of the girl may, after giving due notice, return the instalment of *dejo* already received and offer his daughter in marriage to a more eligible suitor. Once the girl's father has received full payment, however, the marriage must be completed.

In addition to the payment of *dejo* to the bride's father each family spends from Rs. 20 to Rs. 30 in providing a feast (in which liquor takes a prominent place) to the community at the bride's house, and also pays from Re. 1 to Rs. 3 to the village Patil and 1 or 2 rupees to the village *kamgar.*

In the case of a girl's father being dead, her brother or other nearest male relation takes her father's place in arranging for her marriage.

Should either boy or girl die between their betrothal and marriage the boy's parents have no right to claim a refund of the amount of *dejo* already paid.

If a husband dies leaving wife and children she may remarry, but before doing so she must deliver up all the children of the marriage to the care of their paternal uncle or nearest male rela tive of the deceased who then becomes their lawful guardian and

arranges their upbringing and marriages as he pleases. If any of the children are very young, however, they accompany their mother, but go to their father's house when they no longer specially need their mother's care.

Intermarriage between Pawras and Bhils is contrary to the precepts of custom though many so-called "Bhil-Pawras" now exist. If a Pawra woman marries a Bhil she is outcasted by the Pawras and becomes a Bhil. On the other hand if a Bhil woman marries a Pawra she is taken into the Pawra caste on payment by her husband of a fine inflicted by the *panchayat*.

Divorce.—In the case of a breach between husband and wife the latter must leave all the children of the marriage, if any, whether male or female, and may then return to her father's house. She is not permitted to remarry, however, unless the new husband pays to the former husband the full *dejo* paid by him to her father and also all other expenditure incurred by him on account of the marriage, or, in case of dispute, such amount as may be fixed by the *panchayat*. If the new husband pays the amount fixed then all is finally settled, but if he refuses to pay either wholly or partly a quarrel ensues which may even result in manslaughter or murder. In some cases the *panch* steps in and threatens the new husband with outcasting unless he pays up or returns the wife, and this generally has the desired effect.

If the matter be not settled in *panchayat* and the aggrieved husband has little moral force he frequently appeals to the local Government Officials to compel the new husband to repay the marriage expenses or to return the wife.

Birth and Death Ceremonies. —The birth of a child is the occasion for a few simple ceremonies by the mother and a few of her women friends. The death ceremony is peculiar and much more important. There seems to be no rule as to whether the corpse shall be buried or cremated although children are generally buried.

When a person dies the relatives and friends assemble at the deceased's house, each bringing some spirit with him. The nearest relative also provides liquor for those who attend, including the musicians. When all are assembled some *mowha* spirit is poured into the mouth of the deceased and then all present also partake

of liquor. After this the corpse is conveyed to the burial or cremation ground to the sound of drums and mourning of the people. It is a very common practice to put the deceased's *charpai* (bed) and earthen water pots on top of his grave.

Kiria, or death ceremonies, are often repeated at the end of 7 days, 1 month and 1 year after the death of the deceased. If the family be fairly well-to-do a calf is killed and eaten, and liquor distributed amongst relatives and friends who have been invited to the ceremony.

Religion.—Pawras and Bhils may be classed as animists. They acknowledge large numbers of spirits which are almost all malignant and have to be propitiated with blood offerings. Worship is accompanied by wild dancing. The sacrifices and ceremonies are performed by the men. The women of Akrani may almost be said to have no religion. Possession by spirits is believed in, and witchcraft is much practised. But little importance is attached to regular priests or idols, and it is said that the few red-painted stones representing some deity or other that one sees are merely recent innovations since the appearance of a higher caste Hindu element in Akrani.

They have *budwas* ("medicine-men" and witch-finders) who are supposed to be versed in medicine and remedies, both occult and otherwise, and able to prescribe nostrums for diseases and calamities which have fallen on account of displeasure of the gods. They are also supposed to be able to predict the coming of good and evil events.

Evil spirits are often propitiated in time of sickness or other trouble. Many fields are supposed to be inhabited by evil spirits and before such fields are ploughed goats, fowls and ghee are offered to the spirit. In certain cases fields are considered to be so badly possessed that Pawras and Bhils will not cultivate them.

A supreme, or at least superior Being called *Bhagwan* is occasionally referred to though scarcely worshipped; more often they speak of *Wagdeo* the tiger-god. Other deities worshipped are *Ramdeo*, *Gimdeo*, *Hampdeo*, *Parari sutlideo*, *Matadeo*, and the *Pir* at Dhadgaon. The people swear by *Wagdeo* and *Ramdeo*

but on important occasions they also swear by their sons and daughters. Grain, salt and cow's dung are also used for the same purpose.

In Akrani a number of crimes, including murder, may be traced to witchcraft. Sickness in man and beast is generally attributed to the "evil eye" of some unfortunate woman who is considered to be a witch. Suppose a boy or girl, or even a bullock, becomes sick or suddenly dies then some one is immediately suspected and the *budwa* is consulted. He generally points tc the suspected woman, pretending that he does not know her name, and describes her appearance and the locality where she resides in such a way that it can easily be understood whom he means. If any doubt remains another *budwa* is consulted, and sometimes a third. If all *budwas* agree as to the person concerned the women is beaten and persecuted and often tortured in various ways so that she generally has to flee from the village. If the husband also believes that his wife is a witch he sometimes assists in turning her out of the village even if it results in his being left alone with a number of children to look after. More frequently, however, the husband and wife leave the village together.

Frequently witchcraft is taken advantage of by influential men for furthering their own ends. For example, an influential man may covet another man's fields but cannot lawfully obtain them. He may then resort to witchcraft, and after he has assured himself of the support of a few of his friends and the *budwa*, a pretext will be found against the wife of the owner of the field, and she will be declared a witch so that she and her husband must leave the village. Next year it will be found that the man who was instrumental in making the owner leave his field is cultivating it.

There are several forms of ordeal which a woman who is accused of witchcraft may undergo in order to prove her innocence but they are seldom resorted to. Perhaps the most expensive ordeal is for the woman to proceed to Udepur and swear by the Rajah's elephant there. The mahout is first paid Rs. 40 and then the woman is made to stand close up to the elephant, of which she

must be in deadly fear as she can never have seen one before and to say, "If I am guilty let this elephant eat me." One would think that in bygone days a relative of the Rajah's mahout must have advised this remunerative form of ordeal.

Festivals.—The religious festivals celebrated in Akrani comprise *Bhangoria*, *Holi*, *Dewali*, *Dasehra*, *Dihawa* and *Sitara*. At all of them much *mowha* liquor is drunk and dancing engaged in. Were it not for these attractions the Pawras and Bhils would pay but little attention to them as they are not religiously inclined, but they fear and propitiate evil spirits at all seasons.

Bhangoria is the chief festival of the Akrani Bhils and is held only at Dhadgaon, Dhanaja Budruk and Bhogwada Khurd. It is a moveable festival taking place about the middle of March and is dedicated to their great god *Bhangoria*, whoever he may be. This festival is celebrated at different dates in the 3 villages named, first at Dhadgaon (where the biggest celebration is held), then in Bhogwada Khurd and lastly in Dhanaja Budruk. On each occasion a small fair is held in which outsiders join. On the festival days the people of each village come with a party of dancing men and musicians. These dance in turn, each party trying to excel the other, taking copious draughts of liquor in the intervals. Of late years the District Magistrate has ordered the closing of the local liquor shop during this festival, consequently less quarrels ensue and less heads are broken.

The *Holi* festival occurs at the beginning of the hot season, and in Akrani it is divided into 2 parts, *viz.*, the *Sirkari* (government) *Holi* and the local *Holi*. The *Sirkari Holi* is held in all villages simultaneously, as amongst ordinary Hindus of the plains, and large wood bonfires are burned, while the local *Holi* follows, and is held in different villages on different dates spreading over about 6 weeks, according to the convenience of the various *patils* and villagers. Previous to the festival all the people in a village subscribe so that the *patil* may purchase grain and liquor, and then friends from neighbouring villages are orally invited to attend the celebrations on the day fixed. A big bamboo is set upright in the ground and is surrounded by a bonfire. This is lit on the first night and when the bamboo

burns and falls down the headman of the village cuts off a portion of the bamboo with a sword or axe. Others follow according to age, social position and each cuts off a portion. If they are able to do it in one stroke it is supposed to be a favourable omen for a good harvest. After this dancing commences and continues all night, some of the young men painting their bodies to resemble leopards and wearing a tall headdress of peacook feathers. For several days afterwards they go from house to house dancing and receiving money and liquor from the people.

The *Divali* festival is held in various villages on different dates from November to February. Money is subscribed towards the general expenses as in the case of the *Holi* festival, and in all large Bhil villages a young buffalo is sacrificed to *Waghdeo* and the flesh is then divided up and eaten by the people. The Pawras, who are a higher caste, will not eat the flesh of buffaloes or oxen so they sacrifice a goat instead. At this feast there is less dancing than at *Holi* but much more country spirit is consumed with the result that numerous quarrels ensue, sometimes ending in murder.

The *Dasehra* festival, although of considerable importance amongst Hindus in the plains, is not observed by many in Akrani. It is celebrated in the village of Varfalia where the Pawras sacrifice both a buffalo calf and a goat. The privilege of slaughtering the animals lies with the *patils* of Varfalia and Roshmal Budruk, both close to Dhadgaon. In one year the *patil* of Varfalia slaughters the buffalo calf while the *patil* of Roshmal Budruk slaughters the goat, and in the next year *vice versâ*. In each case the *patil* must try to strike off the head of the sacrificial victim with one swing of the sword. The buffalo flesh is then distributed among the Bhils, and the goat is divided amongst the officiating and subscribing Pawras.

The *Dihawa* festival is held when the maize crop is ripe. On the chosen night, which must fall on Wednesday, Friday or Sunday, the villagers gather at the *patil's* house and sing and dance to the sound of the *dholki* (drum) the whole night. Such effort cannot of course be sustained without copious draughts of country spirit! On the following day they

all go to worship the local *Wagdeo*, and having sacrificed some 4 or 5 fowls and 2 or 3 goats and sprinkled some of the blood on the deity they proceed to cook the flesh under a tree near by. Some of this is offered to the idol and the rest is distributed and eaten. This festival spreads over about a fortnight in different villages.

The *Sitara* festival, dedicated to the goddess Sita is a minor festival in which 16 villages take part. In alternate years a buffalo calf and a goat are sacrificed by means of a sword on the banks of the river Udai below the village of Dhanaja. When a buffalo calf is sacrificed the flesh is distributed among the Bhils present, but when a goat is sacrificed it is divided amongst those who have subscribed towards the cost or who have officiated.

Chickens, goats and buffalo calves are sacrificed not only at festivals but also at the taking of vows or *mantas*. The relatives and friends invited to witness the taking of the vows must of course be supplied with country spirit as well as food.

Fairs.—There are two annual fairs held in Akrani outside Dhadgaon, one being held about the 3rd week in October on Astamba peak (the highest in the Khandesh Satpuras), and the other about the beginning of March at Toranmal. The latter is held in honour of Goraknath, over whose image a shrine is erected, and is connected with the Shivratri festival of the higher caste Hindus of the plains. Apart from the Pawras and Bhils of Akrani many Hindus of the plains, both men and women, come miles through the forest and make the very stiff climb. Some, however, never reach the top, either losing the way or finding the climb too difficult.

All offerings made before the shrine of Goraknath are appropriated by a Sadu or Gosavi of Shahada who comes up from the plains at the time of the fair. At other times the shrine is attended by a local Bhil.

Goraknath is supposed to be able to remove barrenness from women provided they fulfil their vows to him. The husband and wife are made to stand before the shrine after bathing in the lake close by; the Gosavi then recites certain prayers which the pair repeat after him, and at the conclusion

both hushand and wife have to lift up a small stone lying before the idol. If they are able to lift the stone (and it appears to be simple enough) it is held to be a sign that the god is favourably inclined towards them and that they will afterwards be blessed with children.

H. W. STARTE, I.F.S.

[*To be continued.*]

OBSERVATIONS ON THE LIFE-CYCLES OF SOUTH INDIAN LAC INSECTS.

Lac insects proper are those that produce the commercial product known as stick-lac. There are other insects which are incapable of producing this raw materal. The former class of insects are to be known by a more connotative name *Lakshadia* and the name *Tachardia* should be retained for the other genus comprising the pseudo-lac insects as these also happen to be greater in number—both these genera being included in the sub-family *Tachardinæ*.

In a paper entitled, "Classification of lac insects from a physiological standpoint," I have explained at length the reasons for such a separation. I have also shown that the insect which grows on *Butea frondosa* in most parts of India called *Tachardia lacca* = *Lakshadia indica* is different from lac insects found in the South.

Possibly there are the following species of insects found elsewhere in India. *Lakshadia nagoliensis* on *Schleichera trijuga*, *L. chinensis* found in Assam and in Indo-China, *L. sindica* on *Acacia arabica* in Sind.

In Mysore we have two insects of this class. One of them occurs on various species of *Ficus*. It was found in the Botanical Gardens at Madras on *Ficus Benjamina*; in Mysore State it usually occurs on *F. mysorensis*, in Hyderabad State it thrives on *F. bengalensis* and to a lesser extent on *Ficus religiosa*; in Bombay it was found on *Albizzia Lebbek*. It is not the *T. ficii* described by Mr. Green in 1903 from *F. bengalensis* in Behar. Some of the type material kindly sent by him, showed a lemon yellow

colour and his insect may possibly be identical with *Lakshadia indica*. Specimens of lac collected by me in the south of India are darker, the colour ranges from chestnut to ruby-red.

This insect is not restricted in the choice of its host plant which perhaps explains its wide distribution. For these reasons it has been called *Lakshadia communis.*

All the insects named so far are supposed to be two-brooded. The insect which is responsible for the lac industry of Mysore has 3 life-cycles a year.

It has been found new to science and has been named *Lakshadia mysorensis.* It has only one host plant on which it thrives naturally, *viz.*, *Shorea Talura* or in Kanarese, *jalari* which is *the* lac tree of Mysore. The nearest locality where lac is commercially propagated is Dorasanipalyam, some 12 miles south of Bangalore and the following records refer to it :—

Lakshadia mysorensis.

1917—November 6th.—Larval swarming observed by Mr. T. V. Subramanyam, Assistant Entomologist, Department of Agriculture in Mysore. This brood was inoculated on a *Ficus* species and on

1918—February 4th.—Wingless males were observed emerging.

1918—April 16th.—Larval swarming.

The following records were taken by me :—

I

1919—December 21st to February 5th, 1920.—Larval swarming continued.

1920—March 10th.—Wingless males were observed and a few winged ones also.

II

1920—April 29th to June 18.—Larval swarming continued.
Emergence of males in this season was not recorded.

III

1920—August 26th to September 22nd.—Larval swarming.

1920—October 15th to November 6th.—Emergence of wingless males.

I

1921—January 24th to February 21st—Larval swarming.

On February 5th the lac contractor started his operations of collection. Trees were seen in flowers on 5th February.

1921—March 29th.—Emergence of wingless males.

II

1921—May 19th to 29th.—Larval swarming was recorded only for this period.

On May 29th the contractor started his operations.

1921—July 10th to 20th.—Wingless males observed emerging during this time.

III

1921—September 23rd to October 23rd.—Larval swarming.

September 27th.—Collection of lac by the contractor started.

1921—December 7th.—Wingless males emerged.

I

1922—February 14th.—Larval swarming noticed. Further dates not recorded.

1922—April 16th to May 5th.—Wingless males emerged.

II

1922—June 17th to July 23.—Larval swarming.

1922—August 7th to August 19th.—Wingless males emerged.

III

1922—October 13th to November 19th.—Larval swarming.

On November 5th profuse swarming started and lasted for about 10 days.

1922—December 25th to January 7th, 1923.—Wingless males emerged.

I

1923—March 23rd to April 10th.—Larval swarming.

1923—April 5th.—Profuse swarming.

1923—May 11th.—Emergence of wingless males.

May 20th.—Emergence of winged males, a few only.

It will be seen that there are not exactly 3 generations in one calendar year. This accounts for the opinion among lac-lessees in Mysore that there are 3 crops in two years, which of course is erring to their advantage.

There appear to be 14 crops in 5 years and the average crop seems to take 4 months and 10 days. Mr. M. Srinivasayya has made a most important discovery that the larval swarming is associated with lunar periodicity and the dark half of the month corresponds with the period of intense larval swarming. In this light there appear to be 3 crops in 13 lunar months. Sudden showers of rains bring about an earlier swarming and late rains predetermine deferred larval swarming. It is possible that the rains themselves may be indirectly influenced by the phases of the moon, in which case it would ultimately become a question of astronomy rather than the meteorology to predict the time of larval swarming. The crop which matures during the rains is the best. The one immediately following it takes the longest duration, and is also poorest in quantity.

The third crop or the one which precedes the rains is the shortest and is more allied to the second crop.

The quantity of lac collected in 3 different periods coincides with the difference in the amount of rainfall and is therefore directly proportional to it. The reason for such a phenomenon is explained in the following manner. The insects harbour inter-cellular micro-organisms which look like yeasts but which are the *conidia* of a fungus, possibly of the genus *Monilia*. The fungus rather than the insect loves moisture and this accounts why the greatest yield is associated with the rains. If time were a factor the best crop ought to have been when the period of growth was the longest, this happens to be the driest period and naturally the fungus is not in a state of vigour. It may be said that the cold

retards the growth of the insect and the low temperature therefore is responsible for the longest period of growth and also for the poverty of the crop.

Considering temperature as the main factor, it would follow that the shortest time would be taken by the generation growing in the hottest part of the year. Although this is true, the yield of crop is not the best at this time. In fact all previous writers on lac divide their crops of lac into cold weather crop which is said to be good in some localities and hot weather crop which is said to be inferior. Heat and not cold has been known as deterrent on the whole rather than beneficial although they have noted that the period of growth is shortest when the average temperature is higher. If we grant moisture as the primary and heat as the secondary factor, we can explain how the best combination of both gives best results during the monsoons, and the defficiency in both the poorest yield during the coldest season which really means the season of least rainfall.

The generation of lac which matures during the monsoons in north India, grows in a season when both these factors are ideally combined. The different contradictory remarks with regard to the best crop being the Baisakhi or the Katki in different localities in India, may be explained in the light of the above explanations.

In Mysore lac also occurs on *Ficus mysorensis* and its insect has been named *Lakshadia communis*. It is a two-brooded insect as the following records will show :—

1916—December—January.—*L. communis* larval swarming on *Albizzia Lebbek* in Bombay.

1920—November 6th.—A parcel of lac which was sent to me from Nirmal in Hyderabad, derived from *Butea frondosa*, the insect being *Lakshadia indica* = *Tachardia lacca* showed larval swarming. This will show the similarity of *L. communis* in Bangalore with this insect up north rather than with the local insect *L. mysorensis.*

1921—March 5th.—On *Ficus Benjamina* in Lalbag Gardens Bangalore, winged males emerged. A good many cells were found empty showing emergence had started some fortnight ago.

1921—July 7th.—On *Nephelium Litchi* in Lalbag, wingless males were observed. Emergence of wingless forms alone continued till July 20th.

1921—September 29th.—Larval swarming occurred on the above *litchi* tree.

1921—October 15th.—Larval swarming on *Ficus mysorensis* in Lalbag.

1921—October 28th.—Larval swarming on another *F. mysorensis* tree in Lalbag.

1921—November 13th.—Swarming on a third *F. mysorensis* tree.

1921—December 6th.—Larval swarming on *Pithecolobium Saman* in St. Mark's Road. Bangalore.

1921—November 15th.—Emergence of winged males from encrustation on *Acacia concinna*, growing near Yaswanthpur village just outside the northern limits of Bangalore Municipality.

1921—December 10th to 1922—January 2nd.—Winged males emerged from encrustation on the ordinary fig tree, *Ficus Carica* in the estates of the Indian Institute of Science which is also near Yaswanthpur.

1922—February 10th.—Winged males on *litchi* tree in Lalbag possibly from the larvæ that swarmed on September 29th, 1921.

1922—March 9th.—Winged males from encrustations on *litchi* in Lalbag, which was inoculated on November 13th, 1921, with brood lac from *F. mysorensis*.

1922—May 16th to 27th.—Larval swarming from brood lac on *F. mysorensis* in Lalbag.

1922—August 12th to 28th—Wingless males emerged from encrustations on *F. mysorensis* outside Lalbag.

1922—September 14th.—Emergence of wingless males on *Anona squamosa* near Lalbag.

1922—September 18th.—Emergence of wingless males on *F. mysorensis* outside Lalbag.

1922—October 11th.—Larval swarming on *F. mysorensis* outside Lalbag.

1922—November 4th.—Profuse larval swarming from brood lac derived from *F. mysorensis*, *Guazuma tomentosa* and *Anona*

squamosa collected from all over Bangalore. On November 19th the intensity of swarming decreased.

1922—December 12th.—Larval swarming from brood lac collected a few days ago from *Anona squamosa.*

1923—March 17th to 31st.—Winged males emerged from encrustation on a creeper variety of rose, possibly Maréschal Niel growing in the bungalow of Dr. Coleman, Director of Agriculture in Msyore, situated in Ali Asgar Road, Bangalore.

L. communis has two life-cycles a year. One generation lasts from November to June both being included, the other begins and ends with the monsoons from June to October. The rainy season generation gives rise to wingless males during August, the drier period generation to winged males which emerge during February to March. The ratio of males to females during the dry season is very great. From circumstantial evidence it appears that even parthogenetic female cells occur during the dry weather. These are somewhat ornamentally sculptured, resembling a crown in shape.

The crop of lac during the dry period is very poor due not to any direct and injurious influence of the weather but to the poor number of females and the unhealthy excess of males, the same insect however does give sufficient quantity of lac on *F. bengalensis* in Hyderabad during June. If the males are not so numerous in this case it is probably due to the lesser rainfall during August to October in Hyderabad as compared with Bangalore. Even in Hyderabad this insect is not artificially cultivated, and when lac is seen in any appreciable quantity on *F. bengalensis* or on *F. religiosa* it is merely collected. There again we do get unhealthy excess of males but not so regularly as is the case in Mysore. During the rains lac is very heavily attacked with *Eublemma amabilis* and this may be another reason why it is not collected in Mysore.

Lac insects proper produce an encrustation which melts and dissolves in alcohol in the manner gum arabic dissolves in water and leaves very little alcohol insoluble residue and whatever it does leave is wax, and this soon dissolves, on the alcohol being warmed. The encrustation breaks with a crystalline fracture and is brittle

like glass. The insects producing it have intercellular symbiotic yeast-like organisms which are possibly *conidia* of the fungus *Monilia.* Both winged and wingless forms of males are known. These alone must be called *Lakshadia* or lac insects proper. The pseudo lac insects must be separated from these and for them the old name *Tachardia* may be retained. The pseudo-lac insects are not spheriodical but distinctly flat specially on the ventral side. Their body-outile is lobed and not circular. They produce a leathery or parchment-like cell which is not fragile and may be cut with a sharp razor without breaking into pieces. It does not melt in the sense shellac does. It is not possible to draw a fine thread with the point of a hot needle. It leaves a large alcohol insoluble residue which is not wax and which does not dissolve in warm alcohol. The manner in which pseudo lac dissolves in alchol may be compared to gum tragacanth dissolving in water wherein it swells before it dissolves. These insects do not give rise to honey dew, they do not contain yeast-like symbiotic organisms. Only winged forms of males occur.

There are two pseudo-lac insects in Bangalore. One is *Tachardia minuta* of Dr. Morrison as my specimens were identified by him and the other is *Tachardia silvestri.* The former grows round about Bangalore most frequently on *Pongamia glabra* and in addition to it on *Michelia Chompaca. T. silvestri* grows most commonly on *Ixora parviflora* and also on *Hamelia patens.* Both these insects have two hosts common between them, *Guazuma tomentosa* and *Santalum album. T. minuta* produces red brown encrustation with a distinct purplish hue not unlike the appearance of the fruits of *Eugenia Jambolana. T. silvestri* is more orange and has not bluish tint about it. In earlier stages it is bright golden yellow. Blood smear of *T. silvestri* reveals the presence of chains of symbiotic bacteria and this easily distinguishes it from the other. *T. minuta* has only one form of female cells. *T. silvestri* has two, one looks like a smaller form of *T. minuta,* the other is flatter and more rough in appearance. The latter I imagine represents parthogenetic form.

An insect belonging to the genus *Tachardia* or pseudo-lac insects was sent to me from Travancore by Mr. Naranayya, the

shellac expert of the State. It grows near about Aramboly on *Acacia Sundra.*

All these pseudo-cal insects do not seem to have a fixed period for larval swarming and for the emergence of males. *T. minuta* from *Pongamia glabra* was inoculated on *Michelia Champaca* which had no sign of any encrustation on it. The inoculation was done on 15th October 1921 and the next larval swarming was observed on 12th August 1922 and thus the life-cycle occupied 10 months. The *Pongamia* tree which had supplied brood for this experiment also showed profuse larval swarming about this time and therefore there was no possibility of a deferred larval swarming on *M. Champaca.* This species of trees had been previously observed attacked with *T. minuta.*

Travancore insects were sent to me in parcels and the following dates refer to them :—

1920—December 10th.—Larval swarming noticed when the parcel was opened.

1921—March 6th.—Larval swarming noticed and it continued till 24th.

1921—May 31st.—Larval swarming noticed and it continued till 14th June.

On 5th June winged males emerged, and the emergence continued for a week.

1921—October 11th.—Larval swarming continued till 26th October.

Winged males emerged throughout this period.

1921—December 23rd.—Larval swarming continued till 1922, January 7th.

A few winged males were seen on the last date.

The following observations refer to *Tachardia minuta* :—

1921—June 28th.—Larval swarming on *Guazuma tomentosa* in Lalbag gardens.

1921—September 20th.—Larval swarming on the same tree.

1921—October 10th.—Larval swarming on *Pongamia glabra* outside Lalbag.

1921—October 15th.—Brood lac from the above tree was introduced on *Michelia Champaca* growing in the estates of Indian Institute of Science.

1921—October 26th.—Larval swarming was most profuse on *Pongamia* referred above.

1921—December 24th —Larval swarming on *Pongamia glabra* on the District Road near the village Dursanipalyam, a locality already referred to.

1922—August 12th.—Larval swarming on *M. Champaca* in the Indian Institute of Science and on *Pongamia glabra* outside Lalbag. Please refer to October 15th.

1922—October 10th.—Sandal-wood trees on the Serpentine Road leading to the Public Offices in Bangalore were found attacked with this insect. A few larvæ had completed their first stage. Most of them had not moulted yet. On 24th October larvæ on *Pongamia glabra* outside Lalbag showed similar stage of development. From this I conclude that the larval swarming must have occurred at the end of July.

1923—January 12th.—Winged males emerged on Sandal-wood trees and also on *Pongamia glabra.*

1923—January 20th.—Larval swarming on *Guazuma tomentosa* growing in the estates of Indian Institute of Science. This tree was not artifically inocculated. Many larvæ had already settled on young shoots but the swarming continued till February 6th.

1923—April 28th.—Winged males had all emerged from the above.

1923—May 20th.—Larval swarming on Sandal-wood trees on the Serpentine Road.

The following records refer to *Tachardia silvestri* :—

1922—February 22nd.—Larval swarming on a Sandal-wood tree in St. Mark's Road, Bangalore.

1922—August 23rd.—Larval swarming on the above tree.

1922—September 14th.—Profuse larval swarming on the same tree.

1922.—December 26th.—Larval swarming on the same tree.

1923—February 23rd.—Winged males emerged from the encrustations on the same tree.

1923—April 23rd.—Larval swarming on the same.

1923—May 20th.—Larval swarming on the same.

1921—December 10th.—Larval swarming on *Ixora parviflora* in Lalbag.

1922—February 22nd.—Larval swarming on *Ixora parviflora* in Lalbag.

1922—December 26th.—Larval swarming on *Ixora parviflora* in Lalbag.

1923—April 23rd.—Larval swarming on *Ixora parviflora* in Lalbag.

1922—December 24th.—Winged males from encrustation on *Ficus Benjamina* in Lalbag.

1923—January 22nd.—Winged males on *Guazuma tomentosa* in Lalbag.

1923—January 25th.—Larval swarming on the same tree which continued till February 6th.

S. MAHDIHASSAN.

FOREST FIRES IN THE ESTEREL.

The news recently published in the *Pioneer* regarding the extensive forest fires in the Esterel Reserve are melancholy reading for any one who knows the country which is one of the prettiest parts of the Riviera. The writer visited this forest twice, once in 1907 and again in 1920 and was very courteously received by the French Forest Officers on both occasions. Forest fires are no new thing in the Esterel and the whole reserve dates from different fires which have swept through it with disastrous effect at various times.

This is hardly to be wondered at when one realises that the soil is poor and rocky, the rainfall very light (20″ to 25″ so far as I can remember) and the growing stock consists almost entirely of highly inflammable conifers chiefly maritime pine with an undergrowth of even more inflammable shrubs similar to the famous Corsican Maquis. There was at one time a good deal of chêne liège (cork oak) but this had been replaced by conifers which were found more profitable.

In 1907 the management had reached a very high degree of perfection and the system of fire protection was better and more elaborate than anything I have seen elsewhere.

There was a lookout post on top of a high hill in the middle of the reserve which was connected with the Garde Generale's office in Frejus and with all the Forest Guards' quarters by telephone.

The whole forest was cut up into small sections by a most elaborate system of fire-lines along ridges, valleys and roads and the undergrowth was systematically removed from various blocks in rotation.

These operations known as "Débroussaillements" were both troublesome and expensive but were found to be the only effective method of dealing with forest fires as it enabled the forest officers to counter-fire and isolate a fire occuring in any of the small blocks in which the forest was divided.

The picture in 1920 was very different as nearly all the staff most of whom had served in the army as officers or non-commission officers were called up and the whole of the elaborate system of fire protection had been practically abandoned with the result that the greater part of the forest was destroyed during and immediately after the war and apparently all that escaped them has been destroyed now.

When I last visited the forest it was difficult to see very much as the fires had been followed by floods which had washed away the roads in many places but the D. F. O. (Garde Generale) very kindly offered to take me out to see the utilisation operations arranged to remove the dead trees left standing after the fire. The Forest Department had built a small jetty for steamers on the coast and had constructed a light tramway into the forest and at one time employed 3,000 German prisoners in cutting the dead trees, loading them on the tramway and shipping them off to Wales as pitprops. When I was there in October 1920 most of the Germans were gone, though I saw a few who had been sentenced to various additional terms of imprisonment, and two of them upset a timber cart in front of us. I was driving in a small mule cart rather like a high dog cart and the old Head Guard who was driving was not a very expert whip.

The delay caused by the timber cart apparently got on the mules nerves and he made up his mind to get home as soon as possible with the result that we ended our tour in a somewhat undignified manner as we were both thrown out and I landed on top of the unfortunate Head Guard who was knocked out of time. The cause of the recent fires is not mentioned in any of the papers I have seen but it seems probable that the French Government have been too busy with their adventure in the rules to devote the usual attention to home affairs. We have not heard of any Geddes Committee in France as the French seem more bent on extracting the last ton of marks out of Germany than in raising funds by retrenchment at home, but it seems possible that they have been cutting down their expenditure on protection, as a fire such as that recently described in the *Pioneer* would have been practically impossible in 1907.

It is a pity that more Indian Foresters do not visit the Forests in the south of France as conditions are far more similar to those of an ordinary Indian Forest Division, than in the North of France, Germany or Switzerland, and it might be well worth for students to visit the "Esterel" even now to study the cause and effects of forest fires. Fortunately forest fires do not do as much damage in the deciduous broadleaved forests of the plains of India as in coniferous forests, but there is a dangerous tendency nowadays to look upon early burning as an universal panacea and underrate the importance of fire protection.

G. M. TOWNSHEND, I.F.S.

DEPARTMENT OF INDUSTRIES, BIHAR AND ORISSA.

BULLETIN NO. 5.

REPORT ON A PROJECT FOR MANUFACTURING PAPER PULP AT CUTTACK,

BY WILLIAM RAITT, I.F.S., M.I. CHEM. E., OFFICER IN CHARGE.

Paper Pulp Section, Forest Research Institute, Dehra Dun.

Mr. J. W. Nicholson, I.F.S., collected information and made a detailed survey of the bamboo resources of the Angul Division and of the neighbouring states, to ascertain whether sufficient supplies would be available to feed a paper pulp factory if one were established at Cuttack. The results of his investigations were embodied, in a report called " Report of the bamboo forests of the lower Mahanadi basin," published in 1922,

The above report was reviewed in the *Indian Forester* of November 1922.

Mr. Raitt has now drawn up a "Report on the project for manufacturing paper pulp at Cuttack" based on the information collected in Mr. Nicholson's report.

Mr. Raitt's report is the first example of the latest development of the activities of the paper pulp section, Forest Research Institute, Dehra Dun.

Hitherto the publications of this section have been dealt with the paper pulp industry in its broad and general application. Now, on the initiation of Local Governments, specific projects suggested by them, are being dealt with.

The report now issued deals with the manufacturing side of the question and the correlation of the forests to the manufacturing facilities available.

It is intended to follow this up with a supplement giving the actual results obtained from Angul bamboo, in the manufacturing plant, at the Forest Research Institute, Dehra Dun.

The author has selected the following extracts from his report, as being the most important and interesting:—

Introductory.

This proposition contemplates the manufacture at Cuttack of Paper Pulp from bamboo grown in the Forest Division of Angul and neighbouring states and floated down the Mahanadi river to the factory side. There exists an important limitation to its scope which it will be well to deal with at once in order to confine this report to the field of opportunity which appears to be open to it. Owing to its distance from a seaport (Calcutta or Vizagapatam) it is not an exporting proposition. Elsewhere in Burma and India locations are known where such factories would be situated on tidal water in close touch with ocean-going steamers direct from factory wharf or with only a short distance of lighterage. Such establishments will be exceptionally well placed for the foreign export of their product and, with them, an inland factory handicapped by considerable rail freight in order to reach the sea could not compete. On the other hand, for the supply of the domestic or local market, Cuttack, appears to be exceptionally

well situated as may be realised from a study of the following circumstances :—

(*a*) Calcutta (with outliers at Raniganj and Lucknow) is the centre of the Indian Paper-making industry, producing about 30,000 tons per annum and importing, 10,000 to 12,000 tons of European wood pulp annually. Such an import, which is yearly increasing provides the opening for a local supply. The market exists. Further the imports of papers are considerably greater than the local production and there is room for a large expansion of the latter provided a new supply of raw material can be found. The local raw materials now in use are already fully exploited, will not provide for any further expansion, and do not even provide for the present output.

(*b*) Areas offering a sufficiently large supply of bamboo and with water transport from forests to pulp factory within a reasonable distance of Calcutta are remarkably few in number. Angul is one of the most favourably situated. Cuttack is 254 miles from Calcutta by rail.

(*c*) Rail freight from pulp factory to paper-mill direct with no intermediate transhipment and handling charges is quite able in this case to hold its own against imports by sea with landing, transhipment and lighterage charges added to sea freight, plus a considerable additional rail charge in the cases of Raniganj and Lucknow.

(*d*) Direct rail communication between pulp factory and paper-mill offers great advantages to both parties. Large stocks need not be carried and finance is therefore simplified. Instead of dealing in shiploads at long intervals, traffic in wagon loads can proceed easily and simply from day to day.

Everything points to the destiny of Angul being that of a feeder of local paper-mills and it is as such that it will be dealt

with in this report. The most economical size unit of a pulp mill is one yielding a production of about 10,000 tons dry pulp per annum. It is governed by the capacity of the drying machine, the most costly item of outfit. A dryer for 5,000 tons costs almost as much to run as one of double the capacity and the expensive technical staff required for the lesser quantity can quite easily turn out the larger so the ton cost of the former is considerably more than the latter. We shall therefore deal with this project as if it is intended for the establishment of the most economical manufacturing unit but will also give the figures for 5,000 tons as also for 5,000 tons of dry weight in the form known as 50 *per cent. moist*. The reasons for and against the latter proposition will be discussed in Section V.

Fuel and Power.

The development of the Talcher coalfield, 65 miles from Cuttack, has an important bearing upon this project. It is doubtful, indeed, if it would be a practical proposition without it, for freight on coal from the older fields would seriously handicap it and wood fuel is not available in sufficient quantity or a low enough cost. A railway is in course of construction to connect Talcher with the main line and the cost of the coal delivered at Cuttack at present pit-head values will be about Rs. 15 per ton. In wood-pulp manufacture the coal consumption is from 15 cwt. to one ton of English coal per ton of dry pulp but allowance must be made for the lower calorific value of Indian coal. We think the consumption will be well covered by putting it a $1\frac{1}{2}$ tons per ton of dry pulp, and the cost per ton of pulp will be Rs. 22-8. For *moist pulp* it will be one ton of coal per ton of pulp costing Rs. 15.

The Factory.

The writer spent several days during December 1921 and February 1923 in examining the facilities offered by Cuttack and its neighbourhood for a factory site. The essential requirements are that the spot selected should have an abundant supply of fresh water and be a common centre to which economical transport can bring the raw and subsidiary materials and from which

the manufactured product can be cheaply and expeditiously removed to its markets. The total quantity of goods to be handled per dry ton of product is 6 tons so that the transport factor is only second in importance to the raw material supply. Cuttack offers a combination of river and rail somewhat rare in our experience and it can also provide the manufacturing water and most of the labour required. The river is an excellent one for rafting, and the anicut which holds up its level for the service of the Orissa system of canals ensures a plentiful supply of water all the year round. The railway communicates with pulp markets and lime supplies and will presently provide a comparatively short connection to the Talcher Coalfield and there is also a water transport route to Calcutta by canal to Chandbally and thence by steamer to the Hooghly river.

The reduction of bamboo to pulp is intended to be effected by the reliable and well proved soda system of digestion which has been in use for many years for the treatment of grasses with certain modifications of method to adapt it to bamboo which have been worked out at the Forest Research Institute. These have resulted in a reduction of soda consumption and a marked improvement in the bleaching capacity considerably beyond what was deemed possible ten years ago. Less drastic conditions of steam pressure give an increase in pulp yield and there is the important effect on soda recovery. This system has the lowest capital cost of any.

Production, Costs and Profits.

The whole of the Capital and Production estimates are brought together in the following table :—

	5,000 tons dry weight in moist form.	5,000 tons dry.	10,000 tons dry.
1	2	3	4
CAPITAL COST.	Rs.	Rs.	Rs.
Pulp making plant, paragraph 13	3,75 0 0	5,40,000	7,60,000
Soda recovery ,, ,, 14	1,00,000	1,00,000	1,50,000
Steam and Power ,, ,, 15	2,55,000	2,90,000	3,25,000
Freight and erection ,, 16	2,20,000	2,90,000	3,60,000
Buildings, etc. ,, 17	4,50,000	4,80,000	5,05,000
Total ...	14,00,000	17,00,000	21,00,000
Working Capital, paragraph 19 ...	3,00,000	3,00,000	5,00,000
Total Capitalisation ,, 19 ...	17,00,000	20,00,000	26,00,000
PRODUCTION COST PER TON—			
Bamboo paragraph 5	30 0 0	30 0 0	32 8 0
Coal ,, 6	15 0 0	22 8 0	22 8 0
Chemicals ,, 8	36 0 0	36 0 0	36 0 0
Labour and Superintendence. ,, 20	20 0 0	20 0 0	12 0 0
Running repairs ,, 20	4 8 0	5 0 0	5 0 0
Sundries ,, 20	8 8 0	10 0 0	9 0 0
Depreciation ,, 18	17 10 0	21 14 0	13 13 0
Add 10 per cent on above say. ,, 20	13 6 0	14 10 0	13 3 0
Cost f. o. r. Cuttack ,, 21	145 0 0	160 0 0	144 0 0
Freight to Calcutta mills. ,, 21	28 0 0	19 0 0	19 0 0
Cost delivered do. ...	173 0 0	179 0 0	163 0 0
PRODUCTION COST PER TON—			
Value of product delivered to Calcutta mills.	250 0 0	250 0 0	250 0 0
Gross profit per ton	77 0 0	71 0 0	87 0 0
Do. percentage on capital ...	23·2%	17·8%	33·5%

Summary and Conclusions.

The correlation of forests, river, manufacturing site rail, fuel and markets is one of the best we have met with and can be unhesitatingly recommended and we know of nothing better for the supply of the local paper-mills. Although estimates have been limited to a production of 10,000 tons, 20,000 is easily possible, the minor difficulty of forest labour being surmounted by progressive effort beginning with 5,000 tons (= 12,500 tons bamboo). The estimates presented are conservative and believed to be capable of reduction and in the case of the 10,000 tons dry production result in a calculated gross profit of 33·5 per cent. on a total capital of 26 lakhs, of which 21 lakhs is Block expenditure, and based on what is regarded as a low valuation of the product. An output of 10,000 tons per annum fills but a small hole in the available market. The existing paper-mills produce about 30,000 tons of paper yearly of which only about half is made from a genuine raw material, bhabar grass, the economic collection radius of which has long since been reached. The other half is chiefly produced from imported Scandinavian wood-pulp and partly from textile washes, rags and contents of the wastepaper basket, and the bulk of the results from the three latter sources the good paper-maker regards as rubbish and would gladly discard if he could. It is these present limitations upon supplies which has prevented the expansion of paper-making in India during the last 15 years in spite of the continually expanding market which is evidenced by the paper imports. The paper-maker can do nothing more to satisfy the needs of the country until he is assured of a new local supply of material and there is none better than bamboo provided it can be given to him at an economic figure by eliminating its waste *in situ* in or near its growing area.

The economic position of bamboo as compared with wood is a very strong one. Only a few species of coniferæ are suitable and the supply of these for pulping purposes has become scarce and dear owing partly to the exhaustion of the more easily exploitable areas but mainly by the competition of the sawmill Both in volume and cost it now violates the fundamental axiom of paper-making, *viz.*, that the industry is based on waste in the

sense that its raw material must have no value for any other purpose. Bamboo is such a waste, pulp-wood no longer is. The cost of the latter is now in but rare cases less than £7 per ton of pulp and in many instances is as high as £9. The corresponding figure for bamboo as shown in the foregoing estimates is from £2 to £2·3·4. It is this difference of £5 to £7 which confers on bamboo an unassailable advantage over wood. It is equal to a 33 per cent. reduction in total cost of production. And against the present local staple, *bhabar* grass (*Ischæmum angustifolium*), bamboo has still larger advantages, the present cost of the former being about Rs. 145 per ton of unbleached pulp—a cost largely due to the demand having outrun the supply. *Bhabar* is one of the best raw materials in the world and possesses qualities which will always give it a place but, with bamboo available, paper-makers can look forward to a reduction of this high cost by resigning their more distant supply areas.

THE INDIAN FORESTS.

BY

SIR SAINTHILL EARDLEY-WILMOT, K.C.I.E.

The Report of the Indian Retrenchment Committee on Forests has been awaited with much interest by foresters throughout the world for the reason that the area involved is enormous, being no less than 23 per cent. of British India, and that the effect of its management on the national welfare is so important. It is now some seventy years since the Government of India awoke to its responsibilities in regard to the forest capital—land and crops—which without purchase had come into its possession. Gradually it became aware of the fact that, unless protected from wasteful use, no natural product, least of all a forest, is inexhaustible, and it is due to the sustained endeavours of the Indian Forest Department that official indifference and national opposition have been converted into enthusiasm on the one part and helpful acquiescence on the other. That very interesting work, *The Forests of India*, by Professor Stebbing of Edinburgh University, gives a detailed account of the struggle for the preservation of the Indian

forests, and has a circulation throughout the Indian Empire and beyond. In order to understand the magnitude of the subject with which the Retrenchment Committee had to deal, the following statistics, taken from the Annual Return of Indian Forest Administration for the financial year 1921-22, merit careful consideration recalling that when conservancy commenced, excepting in some areas inaccessible to the timber merchant of olden days, the forests had been more or less ruined by reason of unregulated commercial enterprise; the capital, as represented in timber, upon which the yearly increment or interest depended, had been seriously depleted, and the quality of the soil, by exposure to tropical and other influences, had much depreciated. Where other countries base their forestry statistics on acreage the Indian forester reckons in square miles, and a comparison of the present yield of the Indian forests by area with that of European countries to him is merely a proof of what may be attained in the future by careful scientific management. The area of the Indian State forests at the end of the period above quoted was 250,473 square miles, and the length of demarcated boundary 151,192 miles; 88,511 square miles had been surveyed in detail. The working of 59,584 square miles was controlled by sanctioned working plans; 45,779 square miles were under protection from fire; and to mention a matter of experimental research, some 170,000 acres of plantation were in being.

Turning now to the income received from, and expenditure incurred in, this vast estate, we find that the gross income in that year amounted to £3,608,566, and the expenditure to £2,427,993, leaving a sum of £1,180,573, which was paid into the Treasury as revenue. The value of produce given free or at reduced rates to the population amounted besides to £585,786. For the five years ending 1873-74, when the organisation of the Department was in its earliest stages, the average corresponding figures were—income, £375,337; expenditure, £262,229; and surplus, £113,108.

It is hoped these statistics will give some idea of the national importance of the Indian forests, of the progress made, and of future possibilities under reasonable management, and we can now turn to the recommendations of the Retrenchment Committee. These, though summarised in two pages, are somewhat

difficult of comprehension. The statements given have reference merely to some minor areas under the direct control of the Government of India, but the provincial forests, which are of outstanding national importance, are not statistically mentioned. It is not known whether the scathing remarks regarding the impossibility of obtaining trustworthy information as to the working or financial results of forest operations are intended to apply only to the small area under the direct control of the Head-quarters Government of India, but as the whole of the provincia forests were, until quite recently, similarly controlled, they cannot escape this adverse criticism. Moreover, as the Administration Report from which the foregoing statistics are quoted includes full details of both areas, it was not 'obviously' impossible for the Committee to have gained some information to aid them in their decisions. The Committee acknowledge that management and development on technical lines is reputed to have been successful but consider that a radical change should be made to management on commercial lines, giving as a reason the excess of timber imports over exports. The control of the forests should be vested, they say, in a manager with commercial experience in the timber industry, assisted by technical experts, and at the same time expenditure in research should be reduced and some indefinite portion of it left to private enterprise.

The question of the commercial management of forests is as old as the forests themselves. It is to the commercial management of the past that the depletion of the forests of the world is due. It is in India and elsewhere that the forester is attempting to restore the exhausted capital, so that in the future a high rate of yearly interest may be obtained for the State, and provision made for the needs of the populace as well as for any unforeseen emergency.

In no industry is it easier to pay revenue out of capital without detection than in forestry, while the chief work of the forester is to improve the capital in land and crop so that the yield will be both high and constant. Examples of the effect of uncontrolled commercialism are everywhere apparent in Europe, in America, and in India, so that it is a commonplace remark that it takes 100

years to repair the injury which may be done by unrestricted commercialism in less than one-third of that time. The restoration of the capital value of the Indian forests has been well begun by the Forest Department, but is still in its infancy. It has persistently been hampered by the financial policy of the Government of India, who delayed development by classifying the forests as a Revenue Department and by taking from it for over fifty years, from one-third to one-half of its gross income, which should have been spent in the organisation of a direct property. Had this been done the forest capital would by now have yielded not three but six or nine, million pounds yearly, with a prospect of increasing values. A forest loan at a high rate of interest, as recommended by one far-seeing Government official, would have saved the situation. For instance, in forestry good communications are vital to financial success, and those Provinces which have attracted railway construction by Working Plans prescribing the out-turn over a term of years are those which show the best results both financially and in the welfare of the population. Transport facilities in roads, bridges, tramways, etc., are expensive, but rapidly repay the outlay by creating distant markets, and without them forests are of little value.

At the same time, it must not be forgotten that the first duty of the forests of India is to supply its 300 million inhabitants with timber for agricultural and domestic purposes and with fuel. If the forests were fully stocked there would be no difficulty in meeting this demand, but in their present condition the commercial timber agent will find little to export save teak and various fancy woods, which have already a good market because the indigenous population cannot afford to utilise them. When the Indian Public Works and Railways are forced to import timber it is evident that at their price, including delivery be it remembered, there is no surplus in India, nor will there be for many years, until the forests become—if allowed to—in fuller bearing. The commercial timber agent can usefully occupy his time in preparation for this period by the construction of transport facilities, if he can get the money from the Legislative Councils, for even a full forest crop without cheap means of distribution will not prove to be a financial success.

It is a curious idiosyncrasy of the majority of the inhabitants of these islands that their thoughts on forests seldom proceed beyond timber. But elsewhere the importance of so-called Minor Forest Produce looms large, and especially is this the case in India. For instance, in the year 1921-22 the value of lac at port of shipment was, in comparison with the total gross revenue of the forests of India, as 76 to 54. Lac is essentially a forest product. There are other products, such as cutch, myrobalans, cardamoms, and a host of other material, such as bamboo, which only require systematic development Their qualities we know, thanks to the splendid work carried out for India at the Imperial Institute which, sad to say, owing to Governmental supineness, has benefited chiefly the pushing alien merchant. Yearly our knowledge of Indian forest products is increasing owing to the pioneer work of the Research Institute at Dehra Dun. Pending the period when the Indian forests are in fuller bearing, and transport facilities better organised, it would pay well to concentrate more on the minor products which are more readily transported than timber and find a good market the world over.

And this brings us to research and its proposed restriction by the Retrenchment Committee. If ever there was a time when the expenditure on research was justified it is at this moment, when the Forest Department has gone, after years of spade work, some way towards the development of its timber areas, and has more leisure, if provided with knowledge, to increase the yield of no less valuable accessory products. The Indian research work at the Imperial Institute, to which we owe so much, combined with that of the local Institute at Dehra Dun, could, if properly arranged and co-ordinated, be the means of providing thousands of pounds monthly as revenue in the future, yet both these agencies for development are to be hampered if the proposals of the Retrenchment Committee are accepted.

The future of India from an industrial point of view has also to be considered. It is to be hoped that in the not distant future the forests in their vast extent will yield not only sufficient raw material for the immediate use of the population, but also manufactured articles for export, for it is in this way that the uncertain

existence of a vast agricultural population will be improved. In the forests of India some 12 million head of cattle graze, and we want no more of the exportation of hundreds of millions of raw hides to Germany to be returned as gloves and other fancy articles, no more of the exportation of raw material such as lac in millions of pounds worth to be bought again with the added salaries of foreign workmen and middlemen. We want to give the Indian craftsman, than who none is better, a chance of making a living out of the products of his own land. And we set about doing this by proposing to save a few thousand pounds by the curtailment of the scientific and technical investigation which we of the West at this time are alone in a position so to carry out that the value and treatment of the country's products may be known and profited by locally.

After thirty-six years in the forests of India, the writer has no bias against commercialism in State Forests, provided it is limited to prescribing the requirements of the market and to disposing of the legitimate yield to the best advantage, and that to the trained forester is left the duty of scientific management with a view to obtaining the highest return on the invested capital. In short, that the forest officer should be assisted by the commercial agent, and not, as proposed, that the latter should control, with the assistance of the forest officer. Should the latter arrangement materialise, there will always be a fear that the commercial agent will, at this stage in the organisation of the Indian forests, be forced to justify his existence at the cost of the timber capital of these forests, say, by the removal in excess of the overwood so necessary to soil protection, or of the immature crop which represents the future capital. For safety, in practice the commercial agent must remain subordinate to the expert forester in regard to the maintenance and improvement of the area, though the latter would gladly hand over the harvest to the former for disposal, and so obtain more freedom for his professional duties in protecting and increasing the yield. The forests of India are a valuable national asset. The proportion of wooded area and its value vary immensely in different provinces. Its management also varies with climate, species, and locality, and no one province is justified

in a selfish utilisation of its forest area, resulting in depreciation of its national value. The advantages and disadvantages of provincial devolution so far as the forests are concerned, therefore, depend on the character and exigencies of the provincial Government. It has before been pointed out that it is easy in forestry to provide revenue out of capital, and some safeguards appear to be necessary to protect national interests against encroachment. Some of these safeguards would be the sanctioning of regular working plans, from which there should be no deviation without permission; the prohibition of alienation of forest land without reference; and approval of proposed appointment of senior administrative officers. For it will be a sad day for the forests of India when the Headquarters of the Government of India renounces all authority over the forest lands which it holds in trust for the good of the people of India as a whole, and over the forest crops which its officers have developed during the past years of strenuous labour. Finally, as to the nationalisation of the Indian Forest Department, the forest officer recognises no distinction of race or colour, and perhaps in no profession is the community of interests more binding or intercourse more helpful. His happiest memories are often of success with untutored savages in the jungle, or of Indians who have shown loyalty and devotion in danger and difficulty.

But the Indian Forest Department has, like other services, its traditions of self-abnegation in exploration, of devotion to duty in loneliness and hardship, of relaxation in sport or science, of loyalty to the forests for which it is responsible, and there is no reason to apprehend that these traditions and this *esprit de corps* will lose in vitality by appointment of Indians to carry on the work so ably inaugurated by their British *confrères*, provided they bring to the task physique and enthusiasm not inferior to that of their predecessors. The present danger is that, under cover of 'retrenchment,' irreparable damage may be done to the steady progress of forest organisation in India, which has hitherto characterised the work of what is rightly regarded as the finest and most effective Forest Service in the British Empire.

[*The Nineteenth Century*, *September 1923*.]

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